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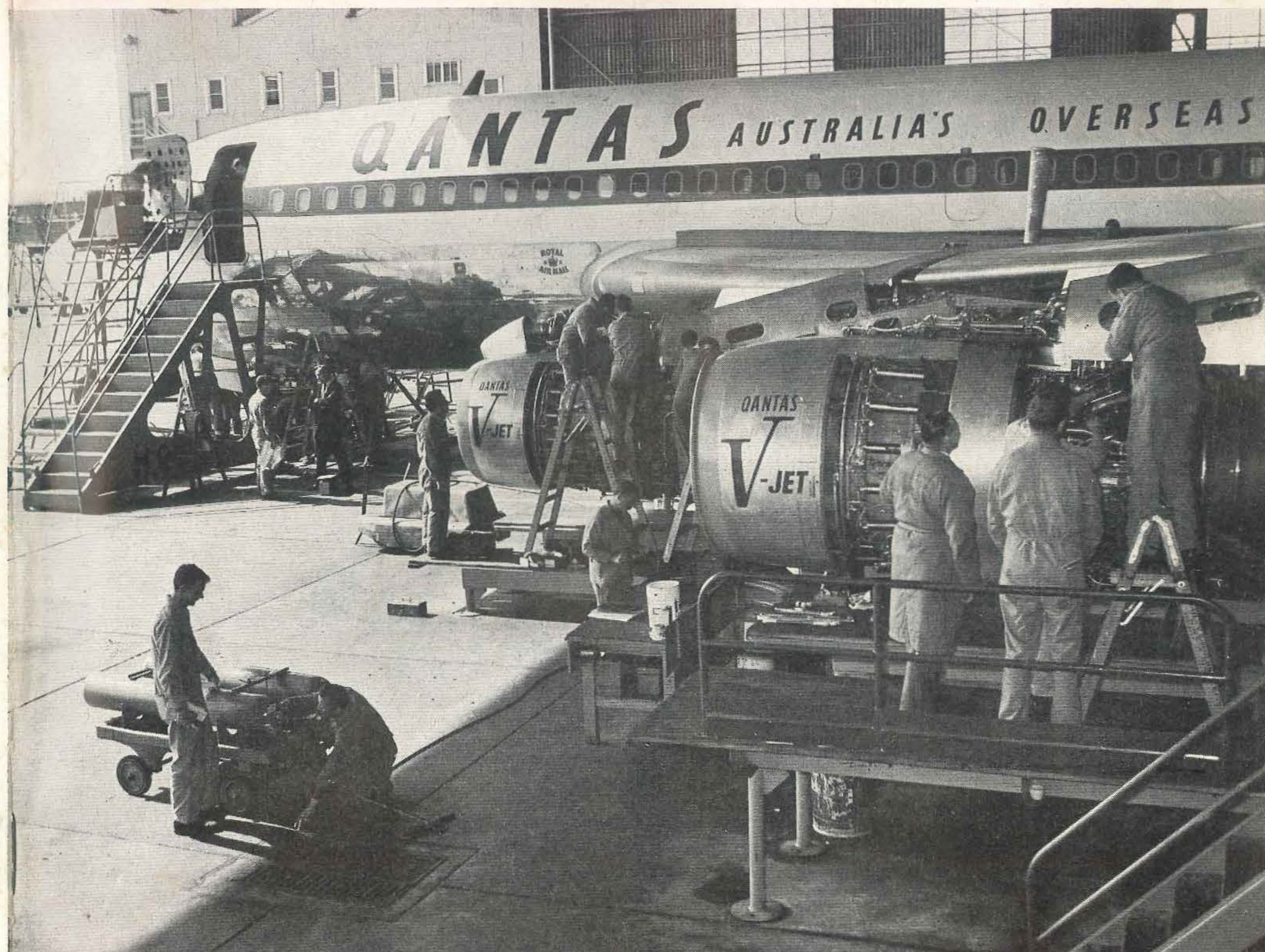
AVIATION SAFETY DIGEST

DEPARTMENT OF CIVIL AVIATION

AUSTRALIA



No. 53

NOVEMBER, 1967

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Department of Civil Aviation . . . Australia

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Contents

Cover: *A Qantas Boeing 707 undergoing overhaul at the Qantas jet base, Kingsford Smith Airport, Sydney.*

Aviation Safety Digest is prepared in the Air Safety Investigation Branch and published at two monthly intervals. Enquiries and contributions for publication should be addressed to The Editor, Aviation Safety Digest, Department of Civil Aviation, Box 1839Q, P.O., Elizabeth Street, MELBOURNE, 3001.

EDITORIAL

TIME TO TAKE STOCK

THE helicopter industry in Australia today is the youngest, but by no means the least important branch of the general aviation family. Although numerically a relatively small section of the total general aviation industry the 80-odd rotary wing aircraft listed in the Australian Register of Civil Aircraft represent a capital investment of some $10,000,000 without taking into account their extensive ground support facilities and expenditure on training ground personnel and aircrew.

In this present era of development and exploitation of our continent's vast natural resources, the helicopter is fulfilling an increasingly important role as a tool of heavy industry and large scale commercial enterprise. Without the modern helicopter's unique ability to operate easily into otherwise inaccessible and often inhospitable localities this development would undoubtedly be considerably hindered. The vital part this type of aircraft is playing in topographical survey work and in the logistic support of oil drilling, to name only two areas of operation, cannot be emphasised too much. It is all the more cause for concern then, both for the helicopter industry itself as well as for the Department, that in the past 12 months no less than 11 helicopters have been lost in accidents. And this, it needs to be said again, is out of a national inventory of only 80 helicopters!

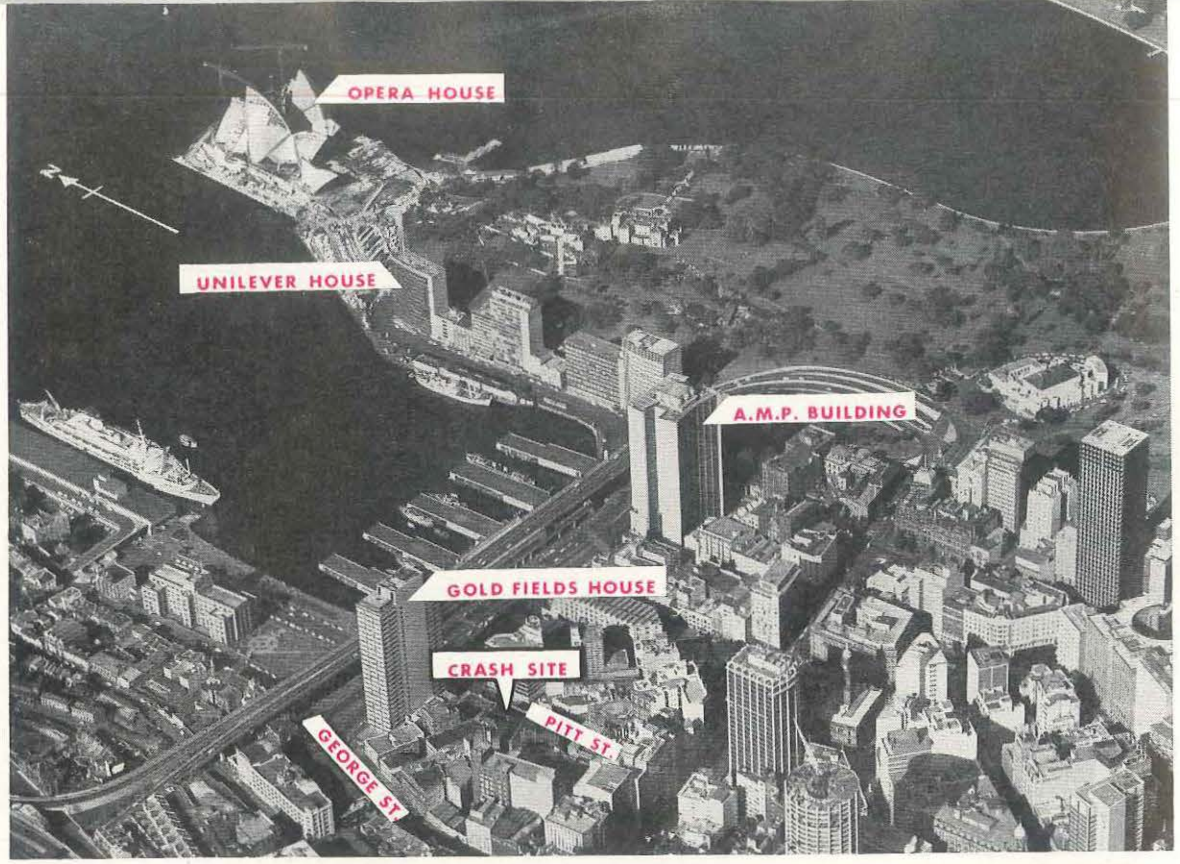
In this issue of Aviation Safety Digest the air safety spotlight has been focussed on three such serious helicopter accidents. Four fatalities resulted from two of these and, as a study of the accident reports will show, it is hardly less than miraculous that the total death roll was not considerably greater.

In featuring these three accidents in the Digest the Department is not suggesting that helicopter pilots and operators as a group are any less responsible than other members of the aviation industry. Rather, it is attempting to show how absolutely necessary it is for those involved in operating helicopters to be constantly vigilant for the unexpected and the unusual which, by the very nature and characteristics of this type of aircraft, can so easily develop.

It is suggested that pilots in every category, whether they be fixed wing or rotary wing exponents, can learn something of value from the helicopter accident reports in this issue as, to a greater or lesser degree, all three include aspects of basic airmanship. But for helicopter pilots especially there is sobering reflection in the old adage ". . . there but for the Grace of God go I . . . ". They would do well to ask themselves whether *their* reactions would in fact have been any different. How confident are they that *their* handling of these emergencies would have produced happier results?

Above all, however, the three helicopter accident reports should be closely studied by the growing numbers of helicopter operators and those who are charged with the responsibility for helicopter pilot training and checking. The reports should pose questions such as "Are our pilots in current practice to handle similar emergencies? Have they encouragement and opportunity to train on the relevant sequencies? If not, what steps could be taken to improve our training programmes?" Seen in the light of these accident reports, questions of this sort take on a fresh relevance.

There is no doubt that the helicopter has "arrived"—it has proved itself and it is here to stay. In acclaiming the immense technological development that it has undergone in its brief twenty years of operational use, let us not overlook the need for constant effort to keep the human element to the high standard of skill that today's machines demand.



Helicopter Crashes in City

At Bankstown Airport, New South Wales, the pilot of a Bell 47G-2 helicopter was preparing to make a photographic charter flight carrying a cameraman and one other passenger, over a portion of Sydney Harbour and the city. The purpose of the flight was to film yachts racing near Kirribilli Point and to complete the film with a run in over the Sydney Opera House, Circular Quay and the city.

At 1330 hours, half an hour before the flight was due to depart, the pilot went to the Bankstown Airport briefing room to lodge his flight plan. Because the details of the aircraft's proposed movements in the control zone were somewhat complex, the briefing officer suggested that the pilot discuss them personally by telephone with Sydney Approach Control.

This he did and it was agreed that the helicopter would be cleared to proceed to Kirribilli Point as soon as it was airborne and on reaching the harbour, would descend to 500 feet while filming the yachts off the Point. The helicopter would then head south to pass over the Opera House at Bennelong Point, and climb to 1500 feet before reaching Circular Quay for its flight over the city. The helicopter would then pass over the Expressway at Circular Quay and complete its filming run by continuing south over the city to the vicinity of St. James railway station.

At 1415 hours, shortly after taking off from Bankstown, the helicopter called Sydney Approach to report it was climbing in the Bankstown circuit area, and requested a clearance to enter the Sydney control zone. Sydney Approach then cleared the helicopter to fly direct to Kirribilli Point.

On reaching Kirribilli Point at 1434 hours, the pilot advised that the yachts it was intended to photograph had not yet reached the Kirribilli Point area, and he requested permission to proceed to Bradley's Head to intercept them. Sydney Approach then cleared the helicopter to operate in the Bradley's Head area.

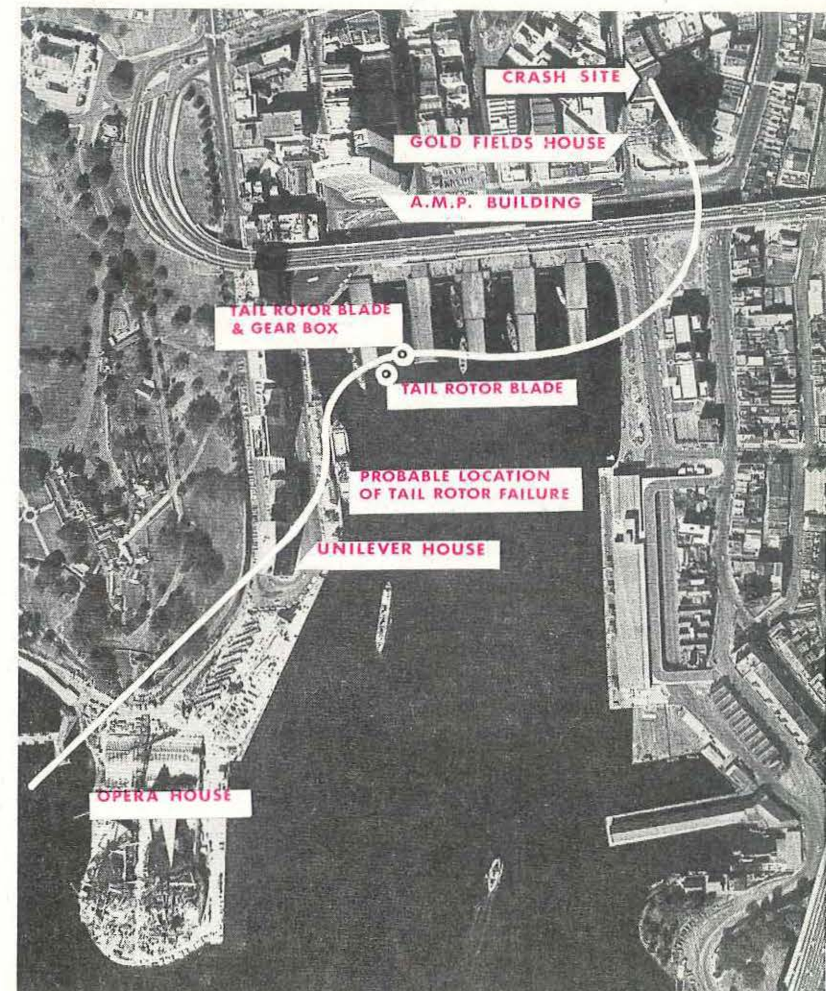
At 1445, the pilot reported that he was leaving Bradley's Head and returning to Kirribilli for the run in over the Opera House and the city. He was requested to report passing the Opera House.

Five minutes later, Sydney Approach Control received a telephone call reporting that a helicopter had lost its tail rotor in the vicinity of Circular Quay. Immediately, the controller called the helicopter twice but there was no response. A Viscount aircraft, inbound from Brisbane, which had just reported 12 miles north of the airport, was then requested to proceed via the Circular Quay area to see if it could sight the helicopter in difficulties.. Within the next three minutes however, several more phone calls were received from various sources, reporting that the aircraft had crashed near the A.M.P. Building at Circular Quay. The Distress Phase of Search and Rescue was immediately declared.

* * *

The helicopter was seen by a large number of eye witnesses as it flew south over the Sydney Opera House and towards the City. Flying normally, the aircraft approached the Opera House from the direction of Kirribilli Point, and, passing over Bennelong Point just to the east of the Opera House, began climbing at a relatively low forward speed as it continued towards the city. It had just passed over Unilever House, on the eastern side of Circular Quay, and had reached a height of approximately 1,000 feet when a pronounced change in the aircraft's rotor noise, drew the attention of people at various locations around and overlooking Circular Quay. The nose of the helicopter was seen to drop suddenly, pieces were seen falling from the aircraft, and the fuselage immediately began to rotate to the right, the opposite direction to the rotation of the main rotor. With the engine still running at about the same power setting, the fuselage continued to rotate about the rotor mast at approximately one revolution per two seconds, while the helicopter maintained height and followed an erratic drifting course towards the western side of Circular Quay, immediately to the north of Gold Fields House. During this time, some witnesses had the impression that the engine power and the rate of rotation of the fuselage varied to a degree, and that the aircraft was gaining a little height as it reached a position over the western side of the Quay. The fuselage, as it rotated about its vertical axis, was clearly unstable and its plane of rotation appeared to be "wobbling" quite violently. This in effect meant that although at times the fuselage was swinging about the rotor mast in a more or less normal flight attitude, at other times the plane of rotation would tilt steeply and the fuselage would rotate in a steep nose-down tail-up, alternating to a tail-down nose-up attitude, giving the impression of a spin. After a number of turns, the plane of rotation seemed to stabilize for a few seconds, then the motion toppled again, this time more severely, as the helicopter swung into a steep nose-up, tail-down attitude. The plane of rotation continued to tilt until the rotor mast was inclined about 60 degrees from the vertical and with the fuselage still revolving, the helicopter began to lose height. The loss of height was slow at first, but it increased rapidly as the plane of rotation steepened, until the helicopter was virtually tumbling end over end at an angle of descent of about 60 degrees. With the main rotor still being driven by the engine, the helicopter fell with increasing speed and, after several more rotations, the rotor blades splintered against the top of the 26 storey Gold Fields House. A moment later the port side of the still tumbling cockpit bubble struck the western wall of the building a glancing blow. Pieces of the main rotor blades fell into George Street on the western side of Gold Fields House, and the fuselage continued its downward plunge until it crashed on the roof of a three-storey building fronting on to Pitt Street, a short distance to the south of Gold Fields House.

Aerial view of Circular Quay area showing final flight path.



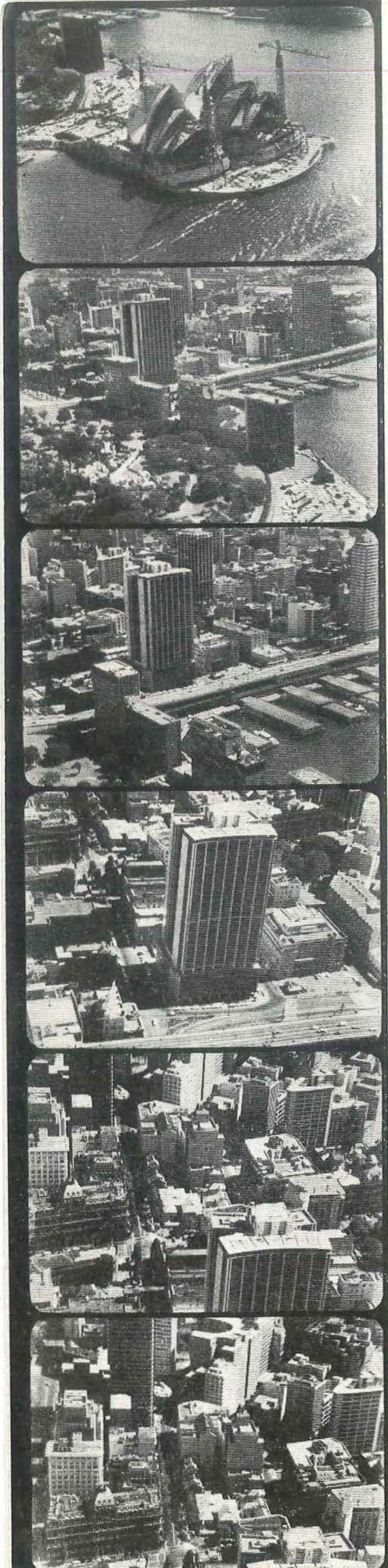
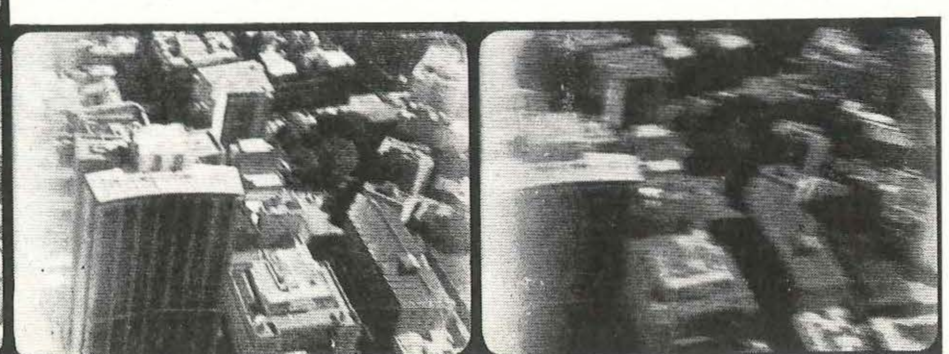
Several witnesses, including a policeman, who heard and saw the crash from near at hand, ran at once to the accident site. Gaining access to the top of the building, they found the helicopter had crashed through the roof, leaving only the tail structure on the roof itself. The wreckage of the fuselage was lying inverted in an office on the upper floor of the building and all three occupants of the aircraft had been killed. Because it was a Saturday afternoon, the office in which the wreckage finally came to rest was deserted, and no one in the building sustained injuries.

The pieces which were seen to separate from the helicopter immediately before it began to rotate, had fallen into the water close to the Manly ferry wharf at Circular Quay. One of the pieces remained afloat and, on being retrieved from the water, was found to be one of the tail rotor blades. Skin divers later recovered the other blade, still attached to the rotor hub and gearbox, from the harbour bed.

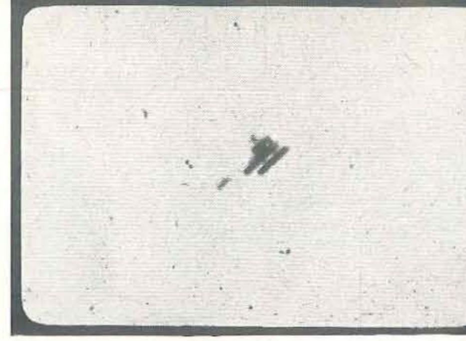
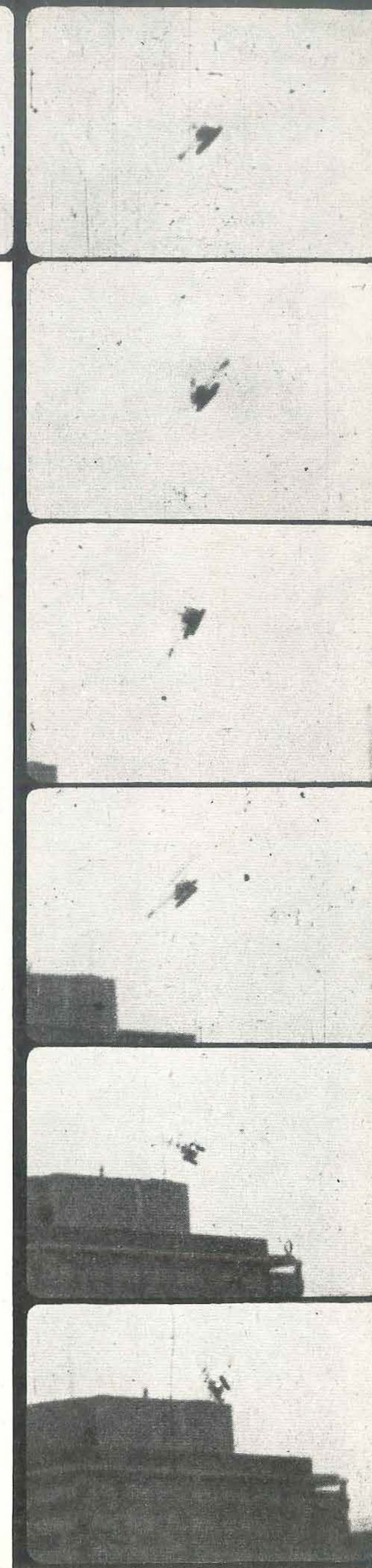
Examination of these components and the wreckage itself, showed beyond any doubt that the helicopter had lost it tail rotor after the retaining bolt for one of the two tail rotor blades failed as a result of fatigue cracking. The tail rotor blade was flung off, and almost immediately the extreme out-of-balance forces imposed on the rotor hub, pulled the entire gearbox and hub assembly from its mounting on the tail structure. Further careful examination of the complete wreckage of the helicopter, revealed no other evidence of any mechanical fault or malfunctioning which could have contributed to the accident.

The circumstances surrounding the fatigue failure of the blade retaining bolt were investigated in detail. At the time of the accident, this type of bolt had a manufacturer's service life of 2,500 hours, but the bolt that failed had actually been in service for only 650 hours. An immediate inspection was ordered of blade retaining bolts fitted to other helicopters of the same type on the Australian Register, and as a result, two further cases of fatigue cracking were discovered. In one, the bolt had been in service for 1200 hours and had developed a fatigue crack just beneath the head, in a position identical to that of the bolt involved in the accident. In the other case, the bolt had been in service for 1100 hours and had fractured through the threaded section, leaving sufficient thread to keep the bolt secured. As a result of the accident, the Department has imposed a limit of 300 hours on the service life of this type of bolt. Since the accident, the Department has learned of two further cases overseas, in which the same bolt in the tail rotor of this type of helicopter, failed in flight. In both instances the pilots concerned were able to make successful autorotational landings without further damage.

As well as the evidence provided by eye witnesses to the accident, the flight path of the helicopter up to the moment of its tail rotor failure, as well as the final gyrations of the aircraft and its initial impact against Gold Fields House, were recorded on two separate cine films. One of these was the film being taken from the helicopter itself, while the other was taken

Film sequence taken from the helicopter showing the aircraft's approach to the city up to the point of tail rotor failure. In the final two frames the nose drops abruptly as the tail rotor is lost and the rotation begins.

Film sequence taken from the tug in Farm Cove. The first frame shows the helicopter rotating in a relatively level attitude. In the following frames the plane of rotation topples, and the helicopter tumbles, still rotating, until it strikes the top of Gold Fields House.

by a film unit which happened to be working on a tug anchored in Farm Cove, 200 yards to the east of Bennelong Point. The film crew on the tug saw that the helicopter was in difficulties and commenced filming it as soon as they could set up their equipment. Their film record shows the final few rotations of the helicopter before it toppled and commenced losing height, and its tumbling descent to the point where it struck and disappeared behind Gold Fields House.

From an analysis of the helicopter's load configuration it is evident that the centre of gravity of the aircraft would have moved to a position beyond the forward limit as soon as the tail rotor assembly was lost. The subsequent flight behaviour of the helicopter, as observed by eye witnesses and recorded on the cine-film, is consistent with the known flight characteristics of the aircraft type. Immediately the tail rotor assembly was lost, the nose of the helicopter dropped and the fuselage commenced rotating to the right at a reasonably constant speed. This fuselage rotation would only have been sustained while engine power continued to be delivered, as shutting down the engine would have removed the torque being applied to the fuselage. Because the fuselage rotation was continuous from the shedding of the tail rotor assembly until the aircraft struck the top of Gold Fields House, it is clear that considerable engine power was maintained at least up to the time of this initial impact. This fact is supported by the evidence of a large number of eye witnesses, nearly all of whom were certain that, although the engine power may have varied to a degree during the helicopter's gyrations, the engine was running right up to the moment of the first impact.

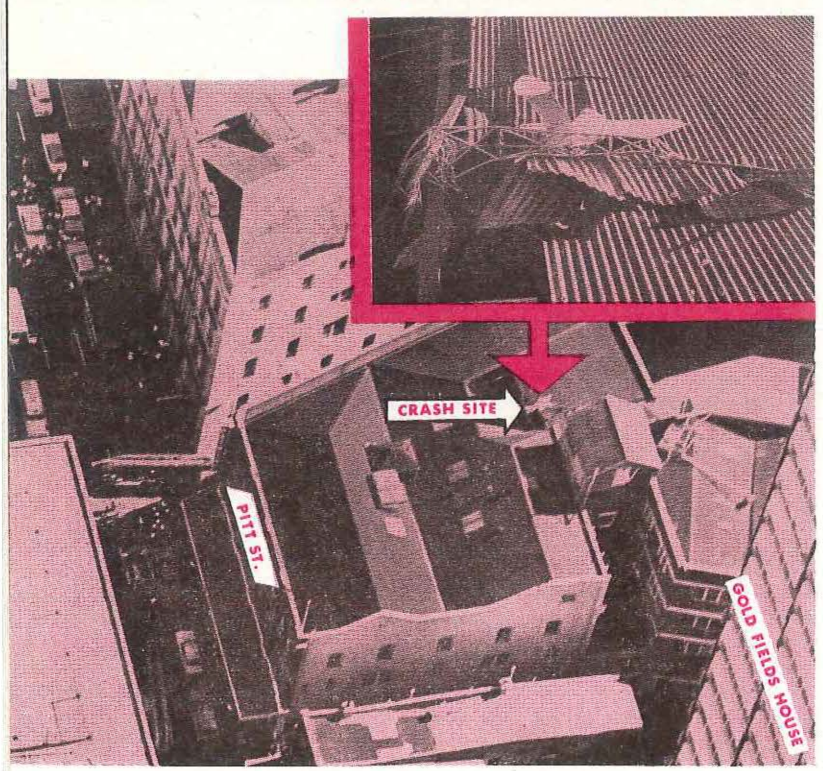
A study of the helicopter's flight characteristics indicates that from the height at which the tail rotor assembly was lost, it should have been possible for the pilot to have accomplished an autorotational descent and landing. The helicopter was equipped with floats and the harbour in the vicinity of Circular Quay obviously offered the most favourable area on which to make an autorotational landing. The chances of successfully completing a forced landing in such circumstances however, would be entirely dependant on the pilot taking immediate action to place the helicopter in autorotation, and would have necessitated increasing the aircraft's forward speed to at least 40 knots. To achieve this condition, the pilot would have had to reduce engine power and lower the collective pitch lever fully. Initially, this would have involved a rapid loss of some 250 to 300 feet of height, while the helicopter was gaining sufficient forward speed for autorotation, but from this point on, a normal autorotational landing should have been possible. Since the helicopter was at about 1,000 feet when the failure occurred, there should also have been sufficient height remaining for the pilot to have carried out at least a 180 degree turn.

The emergency procedures section of the Bell 47G-2 flight manual clearly states that in the event of tail rotor failure, the pilot must "immediately execute an autorotative descent . . ." This of course is a standard emergency drill for any type of tail rotor equipped helicopter, and is normally so much a part of a professional helicopter pilot's training and discipline that when a real emergency develops, the adoption of this procedure should be almost second nature. The possible reasons for the pilot not immediately adopting these procedures were therefore considered in detail in the course of the investigation.

Medical evidence obtained during the investigation shows that it is highly unlikely that the pilot would have been impaired or incapacitated by the effects of the fuselage rotation, particularly while the helicopter was rotating in a relatively horizontal plane. The radial G loading would have been low, of the order of only 1.5G, and should not have had any effect on the pilot's control movements. Only during the final stages of the helicopter's gyrations, after its axis of rotation had altered radically, is it at all likely that the pilot's ability would have been impaired. Up to this stage of the flight, the mild degree of disorientation the pilot would have experienced as a result of the fuselage rotation, should not have handicapped him in any way if he had decided to place the helicopter in autorotation.

Although, under the terms of his commercial pilot's licence, the pilot was required to wear

The final impact site in Pitt Street. The inset shows where the main wreckage crashed through the roof, leaving the tail structure on the roof itself.



glasses for flying, his visual acuity was such that the loss of his glasses during the rotation of the fuselage, would not have had any noticeable affect on his ability.

The sudden, unexpected rotation of the helicopter would, no doubt, have been most alarming to the passengers and, in view of this, the question of whether the pilot's failure to immediately adopt autorotational procedures was the result of interference with the controls by the passengers, is one which must also be considered. It seems unlikely however, that the helicopter's power-on condition was maintained for any reason of this sort. The critical control in this instance is the collective pitch lever, controlling both the power applied to the engine and the power being absorbed by the main rotor blades. In the Bell 47G-2, the collective pitch lever is located on the lower left hand side of the cockpit, whereas the two passenger seats are alongside the pilot's and to his right. In these circumstances, it would be almost impossible for passengers to interfere with the collective pitch lever.

Careful consideration of all the relevant factors leads to the inescapable conclusion that the pilot deliberately chose to maintain a power-on condition after the loss of the tail rotor, despite the fuselage rotation that ensued. It remains therefore, to examine the pilot's motives in deciding upon this course of action and to endeavour to determine what effect this had on the events which led to the final, complete loss of control, and the subsequent catastrophic descent.

The first point to consider is the situation in which the helicopter was placed at the time of the tail rotor failure. By any standards, the situation which faced the pilot was a most unenviable one. The helicopter had almost left behind it the only area, in this case, the harbour, that was suitable for an autorotational landing; it was flying down wind above a complex of busy wharves and harbourside buildings, and it was about to pass over the very heart of the city of Sydney, the streets of which were thronged with pedestrian and vehicular traffic. Although climbing to fly over this intensely developed area at 1500 feet in accordance with the terms of its airways clearance, the helicopter had reached only 1000 feet, and immediately ahead and to either side were tall buildings, some nearly 400 feet high. All in all, although a starting height of 1000 feet would

normally be ample for a successful autorotational descent, it is possible that the close proximity of the city buildings gave the pilot some cause for doubt concerning the helicopter's capability to achieve a controllable autorotational condition in the airspace available. Such reservations would naturally lead him to consider what other alternatives were open to him.

In this context it is pertinent that this pilot had a reputation for being careful and conscientious, and was highly experienced in helicopter operations. It seems that he decided to tolerate the fuselage rotation, in the hope that it might be possible either to manoeuvre the helicopter, or to allow it to drift, into a more favourable position from which to attempt an autorotational landing.

The evidence of some of the eye witnesses who watched the aircraft between the time the tail rotor failed and the final rapid descent began, certainly supports this view. Some witnesses described marked variations in the rate of rotation of the fuselage and others refer to periods during which the rotation appeared to stabilise briefly. Many witnesses made mention of fluctuations in engine power during the period of fuselage rotation, and several were certain that the helicopter rose and subsided on three occasions as it drifted westward above Circular Quay. One witness, who was watching the helicopter from Garden Island, a mile to the east, and who, from this distance, should have had a good appreciation of relative height, said that each time the engine noise increased and the aircraft rose a little, the fuselage rotation rate would increase noticeably, and as this occurred, the plane of rotation would become more unstable. Several other witnesses made reference to the fuselage rotation stabilising on a level plane before the final "topple" and this is also recorded by the cine-film taken from the tug in Farm Cove.

Overall, the evidence seems to point to a situation in which the pilot, while purposefully maintaining a power-on condition, despite the loss of directional control and the consequent fuselage rotation, was struggling to keep the aircraft airborne, and perhaps even endeavouring to gain height, until such time as the aircraft was in better position from which to attempt an autorotational descent.

It must now be asked, to what degree could this course of action be expected to succeed—was it possible, in these circumstances, for the pilot to manipulate the controls in a manner, that would apply the required corrective measures as the fuselage rotated in its out of balance condition?

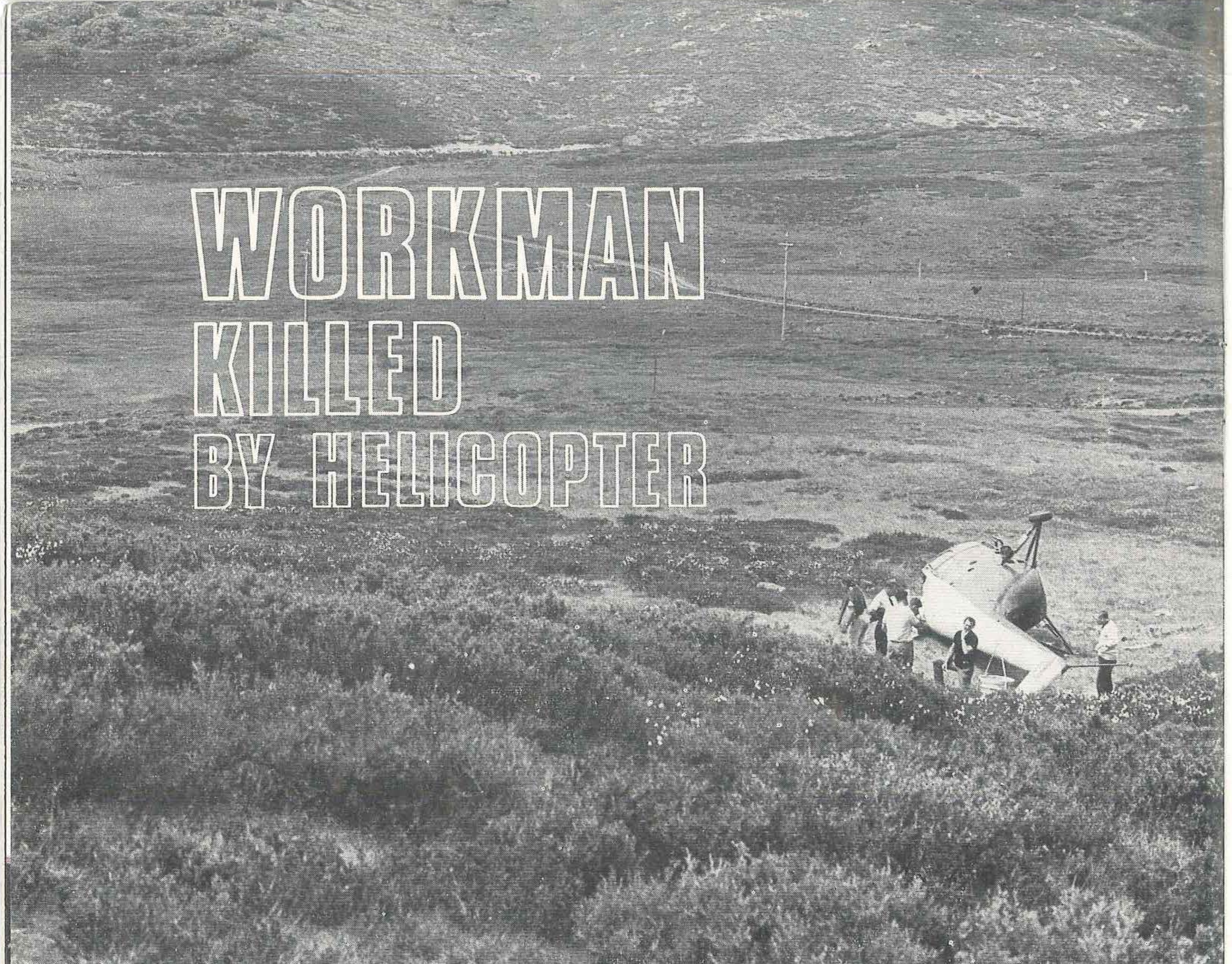
There is little doubt that at best, the pilot could only maintain attitude within the limitations of the available longitudinal control and that even this would be limited by the difficulty of synchronizing control movements with the pitching and rotational movements of the aircraft. Under the conditions imposed by the rotation of the fuselage, there was indeed little possibility that the pilot could control direction, apply lateral control and correct the alternating up and down movements of the nose, simply because the co-ordination required to achieve these control movements at precisely the right moments would be beyond the physical capability of any human pilot. Studies by the manufacturers of the helicopter, show in fact that there is no margin of control available in the event of losing the tail-rotor, if a power-on condition is maintained. Thus, until the pilot removed power from the main rotor, the possibility of maintaining stable flight diminished rapidly with time, and was more a matter of chance than ability. The final loss of control was, therefore, inevitable and only a matter of time while the pilot maintained the helicopter in powered flight.

To sum up then, the investigation shows that, although the events that led to the accident were initiated by a failure of a tail rotor blade retaining bolt, this did not mean that the accident was inevitable. In retrospect, it may seem unfair to criticise the pilot's decision to try and maintain height in the situation in which he was placed, but the fact remains that, irrespective of the terrain over which the aircraft was flying at the time of the tail rotor failure, it was disastrous to attempt to continue powered flight. Notwithstanding the obstruction problem posed by the proximity of the city buildings, it is impossible to avoid the conclusion that had the pilot decided to initiate an autorotational descent immediately the tail rotor failed, the catastrophic results which subsequently developed might have been greatly diminished if not averted entirely.

Cause

The probable cause of this accident was that the pilot, subsequent to a loss of anti-torque control, did not follow the laid down procedure for a safe emergency landing.

WORKMAN KILLED BY HELICOPTER



Accident site as seen from the point where the tail rotor first struck the ground.

During the construction of a new ski lift on a hillside 5,400 feet above sea level at Falls Creek, Victoria, a Bristol Sycamore helicopter was engaged in carrying ready-mixed concrete that was being poured for the foundations of the ski lift pylons.

The helicopter was carrying the concrete in buckets of three cubic feet capacity, suspended one at a time below the aircraft, on a sling four feet long. The upper end of the sling was attached to a release mechanism on the underside of the aircraft and the lower end of the sling carried a snap-hook to which the handle of the bucket would be attached. When the release mechanism was operated by the pilot, it would detach the complete sling and bucket assembly.

The method of operation was for the helicopter to take-off with the sling attached and hover over the loading site while the loading crew attached a bucket of concrete to the snap-hook. The helicopter would then fly to the construction site, hover while the workers poured the concrete by opening the hinged bottom of the bucket, then fly back to the loading site with the empty bucket and hover again while the loading crew replaced the empty bucket with a full one. The procedure would then be repeated. At the completion of the operation, or when the helicopter required to refuel, the sling and bucket assembly would be released from the aircraft before it landed.

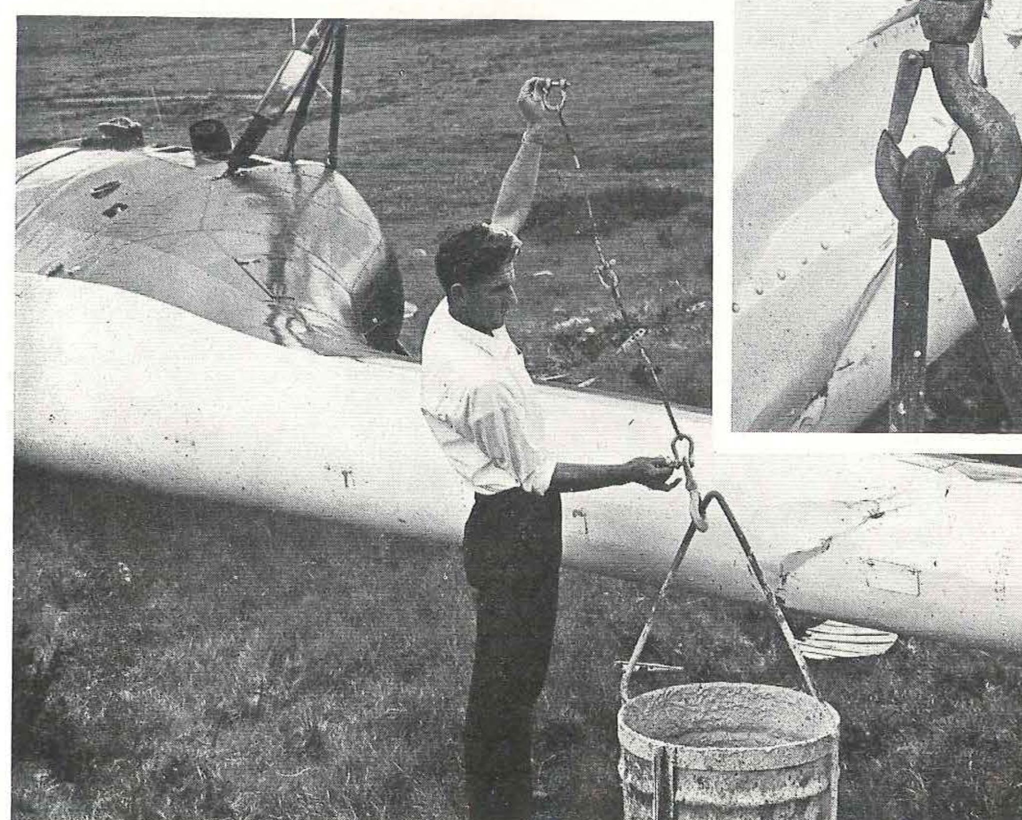
Before beginning operations on the day of the accident, the pilot briefed the workmen on the procedures to be followed with the sling, and warned them of the dangers of working beneath a hovering helicopter. The pilot instructed the workmen that if at any time they thought that some irregularity had developed in the helicopter while it was above them, they were to lie flat on the ground.

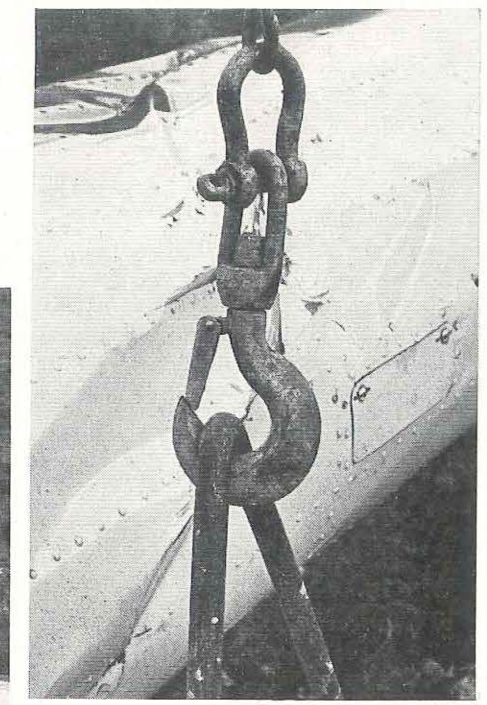
At 1500 hours, two vehicles carrying ready-mixed concrete, arrived at the loading site. The first vehicle manoeuvred into position for loading the buckets, the helicopter took off to hover over the loading site while the first bucket load of concrete was attached to the sling, and the task of pouring six cubic yards of concrete for the first pylon foundation, 300 yards uphill from the loading site, was begun.

Working with three buckets, two of which would be refilled while the helicopter was carrying and dumping the third, work continued for about an hour until some forty bucket loads of concrete had been poured. After each bucket was poured, the aircraft would return downhill to the loading site and remain in hover while the empty bucket was disconnected from the sling hook and another full bucket attached. When the first vehicle's load of concrete was emptied and while the helicopter was dropping the last bucket of this load at the foundation site, the pilot signalled to this effect to the men working there. They indicated to the pilot they required four more bucket loads to complete the pouring of the foundation. The pilot returned to the loading site, released the sling and landed the helicopter at the nearby pad. He then told the loading crew that as only four more buckets were required to complete the foundation, he would take these before shutting down to refuel and take a rest.

The second concrete carrying vehicle was moved into position, the buckets were refilled and the pilot took off again and hovered while the bucket was attached to the sling. He then uplifted the first bucket in the usual way, flew it up to the foundation site and hovered while it

The bucket and sling assembly used to carry the concrete. The inset shows the snap-hook attachment to the bucket handle.





was emptied. The pilot then flew down the hill again and manoeuvred into position for the next bucket load.

As he did so however, the loading crew signalled to him that the bucket and sling were missing. Realising then that the assembly had dropped from the helicopter, the pilot flew directly back to the foundation site, then slowly retraced his previous flight path downhill towards the loading site again. As the helicopter descended the slope of the hill from the loading site downwind, the pilot sighted the bucket on the ground at about the point where he normally turned into wind to approach the loading site. Meanwhile, unknown to the pilot and to others at the loading site, a workman who had seen the bucket and sling fall from the aircraft, was running up the hill to where the bucket lay in the low undergrowth.

From the helicopter, the pilot saw that the terrain where the bucket and sling had fallen was far too rough even to consider a landing, and turned to make a low pass over it. At this stage, the workman from the loading site reached the spot where the bucket lay. Finding the sling still attached, he picked up the sling and held up the shackle, which attaches to the release mechanism on the aircraft, so that the pilot could see it. At first, the pilot had the impression the man intended to hook the sling back on to the aircraft for him, but he then realised that this workman was not familiar with the operating procedure and also that the bucket would have been damaged by its fall. The pilot also reasoned that as the release mechanism must have malfunctioned to allow the bucket to drop, it would have to be inspected before the sling could be re-attached. Still hovering at about 15 to 20 feet above the terrain where the bucket lay, the pilot therefore decided to return to the loading site. Just as he was about to fly forward however, a sudden severe vibration shook the aircraft and the pilot lost anti-torque control. Immediately thinking that the tail rotor had failed, the pilot's first thought was to decrease collective pitch, close the throttle and land the aircraft immediately but, knowing that the workman was still somewhere beneath the aircraft, which was now swinging violently under torque reaction, he attempted to climb the helicopter and roll it to the right. This manoeuvre was unsuccessful and the aircraft spun to the left through almost 360 degrees and the main rotor blades slashed into the ground. The

Deep ground slash made by the main rotor blade after control was lost. Note the partly imbedded rotor blade balance weight.

aircraft then struck the ground on its starboard side, bounced and came to rest on its port side with what was left of the main rotor still thrashing the ground. The pilot cut the magneto switches and throttle and switched off the fuel but the engine continued to run for a time before cutting out. The men at the loading site who saw the accident, immediately ran to the aircraft to assist the pilot out. The pilot sustained only minor injuries, but the workman who had been standing beneath the helicopter had been struck by one of the main rotor blades and killed instantly.

* * *

The weather conditions at the time of the accident were ideal for the type of operation being performed. The helicopter was operating satisfactorily and investigation of the wreckage revealed no evidence of any malfunction or defect that could have contributed to the accident. The helicopter was only lightly laden at the time of the accident and in the existing conditions was capable of hovering either in or out of ground effect. It was established that while hovering at a low height above the sloping ground where the bucket had fallen, the tail rotor of the helicopter struck the top of a small ridge behind the aircraft. This caused the tail rotor to disintegrate and resulted in the loss of control.

It could not be determined why the workman had taken it upon himself to go to the fallen bucket, as he was not familiar with the method of attachment and would not have been able to reconnect it himself even with the helicopter in a suitable position. It can only be presumed that he intended to see how the bucket and sling assembly could be brought back to the loading site.

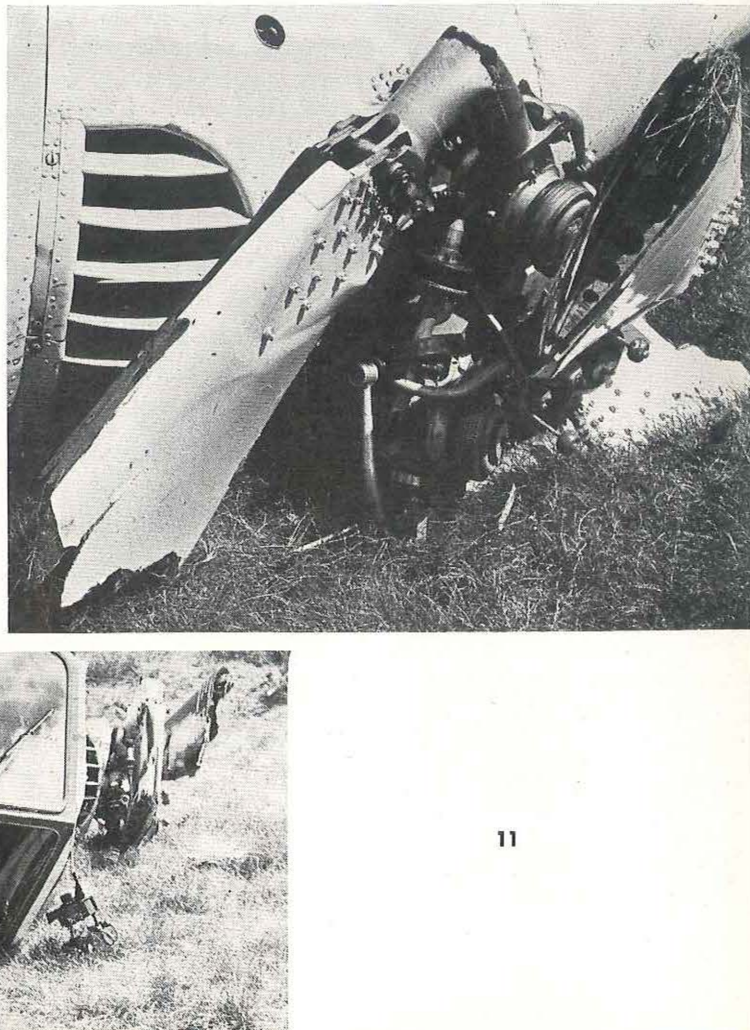
The terrain in the area was quite suitable for the type of operation being carried out but, at the point where the accident occurred, there were complex variations in the contour of the hillside which were difficult to distinguish from the air. Although the pilot was hovering about 20 feet above the point where the bucket lay and the workman was standing, the tail rotor struck the ground only 35 feet behind. With the nature of the terrain however and the direction in which the wind was blowing, it is doubtful whether the pilot could have hovered his aircraft on a more suitable heading. Perhaps if he had fully appreciated the contours of the terrain beneath him, the pilot may have hovered at a greater height, though this would have placed the helicopter in an undesirable position in the event of engine failure. Possibly a pilot more experienced in helicopter operations in this type of terrain, would not have attempted to hover at all in this particular position. It is evident that the pilot believed the height at which he was hovering would provide ample clearance for the tail rotor, but misjudged the slope of the terrain to the rear of the aircraft. The pilot's action in applying power and attempting to climb the aircraft after the tail rotor had struck the ground, cannot be criticised in this instance, as at this stage the helicopter had already commenced to rotate under torque reaction and the pilot was uncertain of the position of the workman beneath the aircraft.

It cannot be established why the bucket and sling fell from the aircraft in the first instance, as the sling attachment was checked and found serviceable. The most probable explanation is that the dispatcher did not ensure the latch was fully locked when the last bucket was attached and that once the concrete had been released from the bucket at the foundation site, the oscillations of the sling during the return flight, caused the locking jaws of the snap-hook to open.

Cause

The cause of the accident was that, having misjudged the slope of the terrain, the pilot hovered the helicopter at a height which was too low to provide safe clearance between the tailrotor and the ground.

View of the wreckage looking back along the flight path. The ridge struck by the tail rotor is just out of the picture in the immediate background.



HELICOPTER Overturns

A Bell 47G-4 helicopter carrying a pilot and two geologists was engaged in mineral survey work in rugged uninhabited country, 50 miles west of Hobart, Tasmania. The survey involved making frequent landings on unprepared areas which were selected from the helicopter as the flight progressed.

In the course of this operation, the helicopter landed on an area of sloping ground, covered with spinnifex-type "button grass." With the 10 to 15 knot wind that was blowing from the west, and in keeping with accepted technique the aircraft was landed into the west at right angles to the approximate five degree overall slope.

When the geologists had completed their observations at the site they boarded the aircraft again to fly to another location. The pilot commenced to lift-off normally but the helicopter's port skid lifted off first, tilting the aircraft further to the right. The pilot slowly increased collective pitch, at the same time applying left cyclic control, but still the starboard skid remained on the ground while the port skid continued to rise. The pilot persisted with his attempt to free the starboard skid until, with the starboard skid still firmly on the ground, the helicopter suddenly overturned to the right. The occupants were not injured, but the rotor blades and mast were broken off and the aircraft itself was substantially damaged.

The skids of this helicopter were fitted with steel "heel plates", each measuring 24 inches by 12 inches, to permit landings on muddy surfaces, and the pilot said afterwards he believed the aircraft had skidded sideways slightly down the slope of the hill allowing the starboard heel plate to become caught under a tuft of button grass.

Though this may have been so, there is no evidence that the accident was caused by circumstances beyond the pilot's control and there seems no reason why a safe take-off should not have been possible if the pilot had not acted so rashly. With any take-off across a slope it is accepted practice to ensure that the downhill skid lifts off first by applying cyclic pitch towards the rising ground, in this case to the left. Although the pilot said afterwards that he believed he had used this technique, the amount of cyclic pitch he applied was obviously insufficient to prevent the port skid rising. Both the pilot and one of the other members of the party said that the rate of lift-off was quite slow. In this situation, the pilot should have had adequate time to assess the trend of the aircraft's behaviour and, when his application of a substantial amount of cyclic pitch failed to free the starboard skid, he should have discontinued the attempt to take-off until the trouble was remedied. There is no doubt that the accident arose from the pilot's continued application of collective pitch while the starboard skid was in some way caught on the ground.

Perhaps the most surprising aspect of this accident is the pilot's very extensive flying experience, both in helicopters and fixed wing aircraft. The accident is another vivid example of the degree of care necessary to safely operate a helicopter from sloping ground.

DME DIFFICULTIES

Immediately after departing from Cairns, Queensland, for Townsville, the crew of a Viscount found that the DME reading was about seven miles too much. The aural identification was unreadable but in other respects the operation of the DME appeared normal and the red bar did not move across the face of the DME distance indicator.

The crew requested Cairns tower to advise whether or not the DME beacon was operating normally and on being informed that it was, continued to check the readings against their visual position. By the time the Viscount was 65 miles south of Cairns the DME was over-reading by 11 miles and the signal identification code was still unreadable. When the crew selected the Townsville DME channel, the indicator immediately settled down to a correct reading and the normal identification code was received. The Cairns DME channel was then re-selected and this time gave the correct reading with the Cairns identification code.

Reporting the incident, the captain said that the aircraft's DME equipment had been tested while the aircraft was parked on the apron before the engines were started, and seemed normal, but he had not noticed the reading the equipment was giving before they took off. The take-off was made on the 15 runway and, as the aircraft's track for Townsville was a continuation of the runway heading, the aircraft did not pass over the DME beacon which is sited four miles north of the airport. He and the first-officer first noticed the error very shortly after take-off and immediately checked the signal for identification but found the code unreadable.

Investigation of the incident showed that the erroneous distance indication was another case of what is technically known as "range stealing". This phenomenon occurs when an aircraft's DME receiver "locks on" to an echo of the signal transmitted by the DME beacon, but reflected from terrain or buildings, instead of locking on to the signal itself. The echoed signal is responsible for the false distance reading. The phenomenon is comparatively rare, but is most likely to occur where, as in the case of the Cairns DME, a beacon is situated close to high terrain. Erroneous readings are more likely to be experienced close to a station than at greater distances from it.

The possibility of an aircraft receiver locking on to an echo, instead of the direct signal, can be minimised when preparing to depart from DME equipped aerodromes, by interrogating the transmitter when the distance indicator has run almost to its maximum range. The first "lock on", starting from zero, would then be the correct signal. De-selecting the channel immediately after take-off and then re-selecting it when the distance indicator is searching at maximum range, will reduce even further the chances of locking on to an echo.

This technique can also be employed if a DME error arising from range stealing is suspected in flight. Another channel, which will allow the distance indicator to run to maximum range should be selected, and the desired channel re-selected as the indicator approaches its maximum range. This enables the equipment to begin searching from zero again and ensures that the direct signal is sampled before the echo, thus increasing the likelihood of locking on to the direct signal.

A similar problem to range stealing can sometimes occur when an aircraft's DME equipment ceases to indicate the distance from the selected beacon and locks on to another equi-distant beacon, or when the aircraft's DME fails to lock on to a distant beacon that has been selected, and instead indicates the correct distance from the nearer beacon of another channel. Though also rare, this situation can be produced by pulses reflected from terrain or buildings, combining in such a way as to form a "pulse pair" of just the right spacing required to trigger the unwanted beacon. The replies are then transmitted by two beacons and the DME equipment in the aircraft is actuated by the stronger signal.

The potential that exists for errors of this sort, small though it is, emphasises the importance of monitoring DME station identifications frequently. In the case of range stealing as in the incident cited, the identification code will be either mutilated or non-existent. In the other situation mentioned, the identification of the unwanted station will be received. Thus, provided a DME beacon's identification is monitored frequently, no real navigational difficulties should arise. It is a sound rule never to accept a DME distance indication unless the identification code is clear and correct.

Aquaplaning hazards on wet RUNWAYS

Earlier this year, during the investigation of an accident in which a Viscount overran the runway while landing at Brisbane in heavy rain, the phenomenon of aquaplaning was suggested as a possible contributory factor. The phenomenon of tyre aquaplaning on wet or slush-covered runways, has probably been a factor in a number of accidents and incidents in Australia in recent years and is a potential hazard which should be clearly understood by all pilots. (See also "Landing on Wet Runways", Aviation Safety Digest No. 39, September 1964). Every pilot, whether he be full-time professional or weekend flying enthusiast, sooner or later has to contend with a landing on a rain swept airport. For this reason, a knowledge of the factors that can produce an aquaplaning condition is most necessary for pilots if they are to avert the hazard.

When pneumatic tyres are rolling over a water-covered pavement, hydrodynamic pressures are developed between the tyre "footprint" and the pavement. These hydrodynamic pressures increase as the ground speed of the aircraft increases, until a critical speed is reached where the hydrodynamic lift resulting from the build-up of pressure under the tyres equals the weight riding on the tyres. When this occurs, the aircraft has reached its aquaplaning speed and any increase in ground speed above this critical figure, will lift the tyre completely off the pavement, leaving it supported by the fluid alone. This situation is called total tyre aquaplaning.

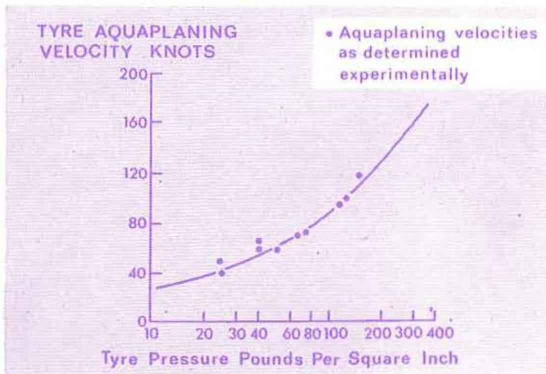
Research that has been carried out on the phenomenon of aquaplaning, shows that tyres will not aquaplane on a wet paved runway surface unless it is flooded or heavily puddled with water or slush. Although most runways in use today are designed with a crown or a cross-fall gradient to drain water away readily, caution needs to be exercised in deciding whether or not aquaplaning is likely to occur in a particular set of circumstances. For example in rain storms involving cross-wind components blowing in a direction opposite to the cross-fall of a runway, the wind can hold water back and allow it to accumulate on the runway surface to the point where aquaplaning conditions are produced. Similar situations can develop on one side of a runway designed with a centre crown. Then too, bald or smooth tyres tend to aquaplane in shallower depths of water than tyres with a ribbed or patterned tread, and aquaplaning can occur on a smooth runway surface in shallower depths of water, than on a rougher surface. Studies in fact, show that smooth tyres can aquaplane on a very smooth pavement in only one tenth of an inch of water whereas two or three tenths of an inch of water are necessary for ribbed tread tyres to aquaplane on a rough textured pavement.

Experiments to determine at what speeds total tyre aquaplaning can occur, show that variations in the vertical load acting on a flexible pneumatic tyre, produce corresponding changes in the ground-contact area or "footprint" of the tyre, in such a way, that the ratio of the load on the tyre to the area of the "footprint", approximately equals the inflation pressure of the tyre. Working from this result, it can be shown that a tyre's total aquaplaning speed may be defined in terms of the tyre's inflation pressure by means of the relationship:

$$Va = 9\sqrt{p}$$

Where Va equals the total tyre aquaplaning speed in knots, and p equals the tyre inflation pressure.

Figure 1



For example, a tyre with an inflation pressure of 100 lb. per square inch, would have a total aquaplaning speed of 90 knots. The equation is theoretically valid for both smooth and treated tyres, provided that the depth of water on the runway exceeds the thickness of the treads. Figure 1 shows this relationship graphically, compared with actual aquaplaning speeds determined experimentally, using various combinations of tyre sizes, inflation pressures, and wheel loadings. It must be remembered however that under actual operating conditions, other variables are also involved and even when conditions are theoretically conducive to aquaplaning for a particular case, aquaplaning may not necessarily occur.

When aquaplaning occurs at ground speeds above a tyre's total aquaplaning speed, the tyre lifts off the runway surface completely, the frictional forces between the tyre and the ground fall to insignificant values, and the tyre loses virtually all its traction. At the same time, the hydrodynamic lift acting between the tyre and the ground produces a reaction which tends to slow down the rotation of the tyre. As a result of these two effects, the wheels of an aircraft can spin down to a complete stop if the aircraft is aquaplaning at a ground speed at or above the total aquaplaning speed of its tyres. This means that at total aquaplaning speeds, an aircraft's brakes become almost completely ineffective and the aircraft will skid severely under the action of only a small sideways force such as a cross-wind. Tyre to-ground friction can be reduced even at speeds lower than a tyre's total aquaplaning speed, if there is a sufficient depth of water lying on the

AIRCRAFT TYPE	STOPPING DISTANCE (Normal Landing)	
	DRY	WET
"A"	2660 ft.	4740 ft.
"B"	2392 ft.	4740 ft.

Figure 2

runway to produce a partial aquaplaning condition. For these reasons, smooth or excessively worn treaded tyres should not be used on aircraft which are likely to have to operate on wet runways.

The dangers arising from conditions conducive to aquaplaning are thus greatly increased stopping distances and loss of directional control on the runway. The table at Figure 2 compares the "wet" and "dry" stopping distances of two similar aircraft fitted with different braking systems, using brakes only. Aircraft "A" has a braking system designed for normal all-round operation, and aircraft "B", a braking system, specially designed for experimental purposes, to stop in an abnormally short distance in dry conditions. Note how the increased stopping efficiency of aircraft "B's" braking system has no effect in reducing the stopping distance in wet conditions.

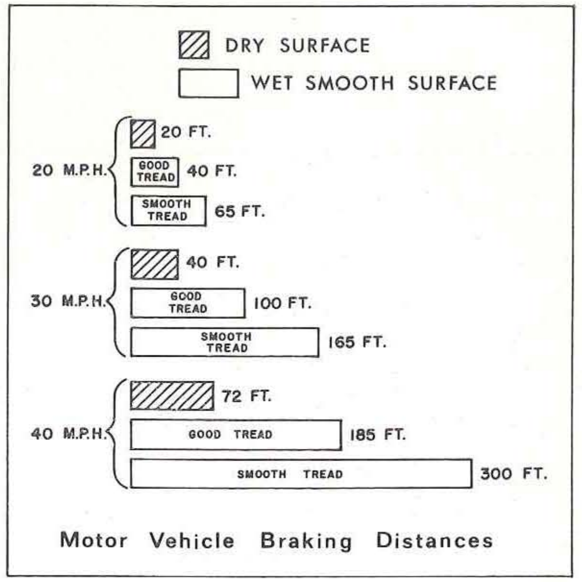
The actual stopping distances of different types of aircraft under operational conditions on wet runways, will of course depend on what use is made of devices such as reverse thrust, ground fine pitch or reversing propellers, spoilers and other aerodynamic devices. For this reason it is not possible to describe or illustrate the effect of wet runways on aircraft stopping distances in a completely general manner.

From the foregoing however, it should be clear to all pilots that a landing on a rain-swept or flooded runway is an exercise calling for a high degree of caution. In these conditions, pilots should employ techniques which will minimize the increase in stopping distance and the possibility of losing directional control. Operational techniques such as using the minimum safe touch-down speed, early runway contact and early use of spoilers, where fitted, should be adopted to decrease the landing roll. Reverse thrust and wheel brakes need to be used with care in these conditions, as any asymmetrical thrust or drag on the aircraft could make control difficult on a slippery runway. Different runway surfaces provide different degrees of adhesion which produce variations in braking effectiveness and resistance to sliding. Also, well used runways accumulate tyre rubber on the touch-down area that can contribute to slipperiness when wet, and after a long dry spell, the surface adhesion of bitumen runways can become slippery in conditions of only light rain.

Pilots should also remember that the effect of a cross-wind during a landing on a wet or slippery runway can greatly increase the chance of losing directional control. It is most important in these circumstances that all drift is eliminated before the aircraft touches down. Where runway conditions appear critical for a landing, it may be prudent for pilots to adopt a more conservative cross-wind component limitation than that stipulated for their aircraft. Obviously however, where there is any choice of runway, it is better to accept a slightly higher cross-wind component on a longer, wider runway, than a lesser component on a shorter, narrower runway.

With all aircraft types the likelihood of a total or partial aquaplaning condition developing during a landing on a wet runway, can be reduced by making a firm touch-down, then lowering the nose wheel as soon as possible after the aircraft has settled. This has the effect of driving the landing wheels through the film of water to make positive contact with the runway surface, and

Figure 3



then ensures that the maximum amount of weight is transferred to the wheels, early in the landing roll when the danger of aquaplaning is greatest. Retracting the flaps early as a means of placing more weight on the wheels is not generally recommended as the increase in braking effectiveness this achieves, is usually offset by the loss in aerodynamic drag.

Finally a word to those who also drive cars!

What has been said about the phenomenon of aquaplaning in relation to aircraft operations on wet runways applies also to motor vehicles being driven on wet, paved roads. Indeed, because the inflation pressures of motor tyres is generally much lower than for aircraft tyres, aquaplaning can occur more easily, and at speeds well within legal limits. When converted to give the answer in miles per hour, the total tyre aquaplaning speed formula already quoted, becomes:

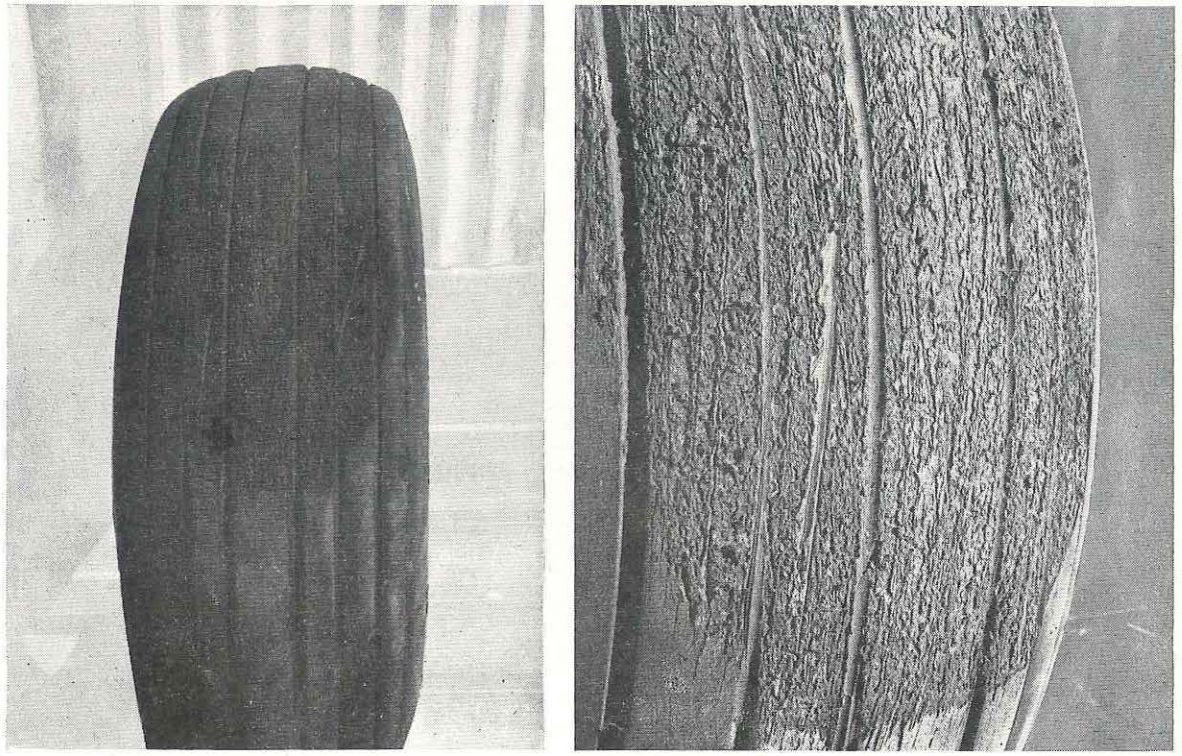
$$Va = 10.4\sqrt{p}$$

Thus it is possible for motor car tyres with an inflation pressure of 16 pounds per square inch to aquaplane at 42 m.p.h., ones with a pressure of 24 p.s.i. at 51 m.p.h. and tyres inflated at 32 p.s.i. can aquaplane at 59 m.p.h.

It is worth emphasising again that *all* traction is lost (and this includes cornering ability as well as braking traction) at aquaplaning speeds, so that a wet road can, in effect, be just as slippery as an icy road. The effect of wet pavements on the stopping distances of motor vehicles is shown in Figure 3.

In wet conditions it is good practice to drive at lower speeds and to increase following distances behind other vehicles, to allow for these increased stopping distances. Being alert for standing water or puddles, especially on curves, as well as for side winds which could affect control of a vehicle, will also make for safer driving in the wet. As with treaded aircraft tyres, motor tyres in good condition, correctly inflated, will be less susceptible to aquaplaning than smooth or worn tyres.

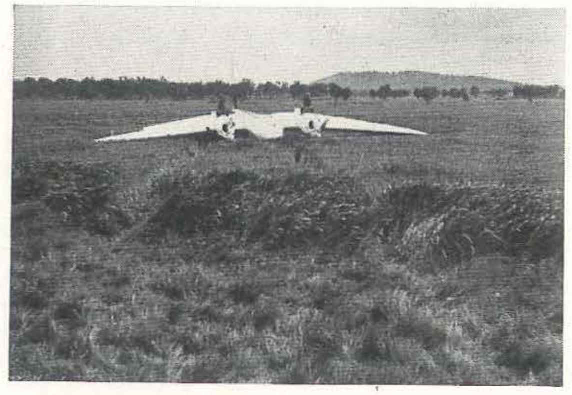
An aircraft tyre exhibiting tell-tale effects of aquaplaning. The abraded sections of the tread are not skid marks but patches of heat affected "reverted" rubber. This effect has been produced by super-heated steam, generated in the film or water beneath the tyre, when it ceased rotating while aquaplaning at speed.



Loss of Directional Control

While attempting a cross-wind take-off from Cootamundra, N.S.W., a Super Aero 45 left the runway, ran into an adjoining wheat crop and nosed over on to its back. The aircraft was badly damaged but the pilot escaped with only minor injuries.

The aircraft belonged to a charter company and was being ferried to Bankstown, N.S.W., in preparation for a period of fish spottings operations on the south coast of New South Wales.



After an uneventful flight from Port Lincoln, South Australia, the aircraft landed at Cootamundra to refuel. The surface wind was blowing from about 200 degrees gusting between 10-15 knots and during the cross-wind landing, which he made on the aerodrome's 161 degree strip, the pilot found the aircraft difficult to handle. For this reason and because he saw that other aircraft were using the 281 degree strip, the pilot decided he would use the 281 degree strip for his take-off when his aircraft had been refuelled and he was ready to continue his flight.

The take-off seemed normal until the aircraft became airborne but almost immediately it began to settle back towards the runway surface again. In the cross-wind condition, however, the aircraft had already acquired a considerable amount of starboard drift and the pilot attempted to hold the aircraft off the ground. As he was doing so, the starboard wing dropped violently and the wing tip, the starboard undercarriage and tail wheel struck the ground simultaneously, slewing the aircraft sharply to the right. The pilot closed the throttles to abandon the take-off and the aircraft settled on all three wheels but it ran off the strip to the right and into an adjoining wheat crop. The growth was two feet high and particularly thick with the ground beneath wet and muddy. After running through the crop for 230 feet the main wheels dug in and the aircraft nosed over on to its back. Amongst other damage sustained by the aircraft in the crash, the cockpit canopy was broken and distorted, and the pilot was unable to extricate himself from the aircraft until assistance arrived.

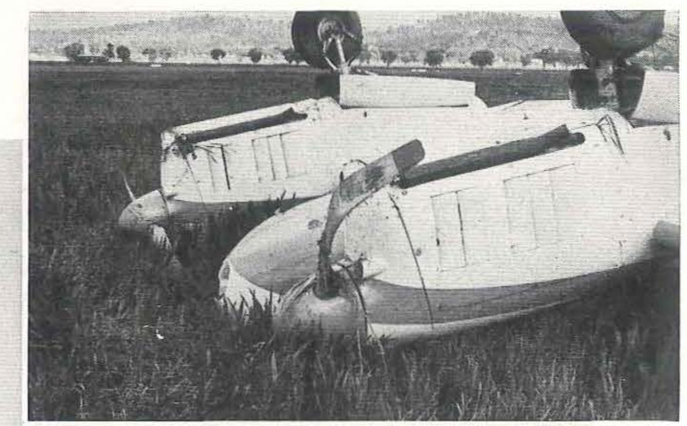
The pilot held a commercial licence and had a total of 600 hours flying experience. His experience on Super Aero 45 aircraft amounted to 120 hours. Discussing the events leading to the accident, the pilot admitted that, with the wind blowing from 200 degrees, the 161 degree strip on which he landed was more favourable for a take-off than the 281 degree strip. With a wind strength of 10-15 knots the cross-wind component on the 281 strip would have been very close to, and at times, probably above, the maximum permissible cross-wind component for the aircraft type. The pilot said that in choosing the 281 degree strip for take-off in preference to the 161 strip, he was influenced by the fact that several other aircraft took-off and landed on the 281 strip while his aircraft was being refuelled.

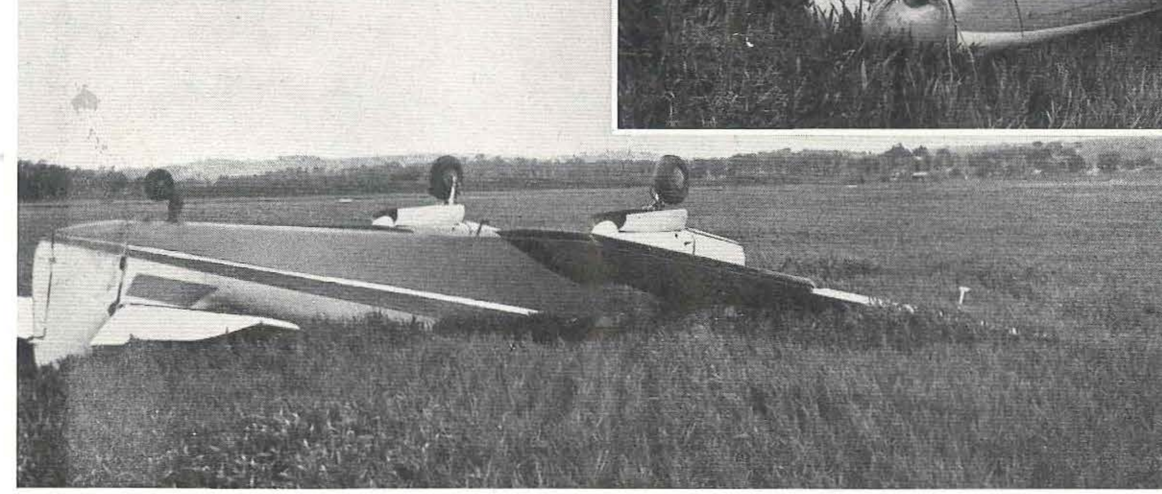
Although the pilot said that the aircraft initially became airborne at its normal lift off speed, it was subsequently found that he believed this to be 45 knots. The Department prescribes that the take-off speed for light aeroplanes shall be not less than 20 per cent greater than the aircraft's stalling speed with power off. From the flight manual for the Super Aero 45, it was determined that, at the weight to which the aircraft was loaded at the time, the take-off safety speed was 56 knots or 11 knots greater than the speed at which the pilot allowed the aircraft to become airborne. It is obvious that, in the existing gusty wind conditions, a lift-off speed of 45 knots would have provided insufficient margin above the stall, to achieve the lift and positive control necessary for the aircraft's initial climb. As a result, it is not surprising that the aircraft began to settle again almost immediately. In his efforts to keep the aircraft off the ground, the pilot evidently raised the nose still further, increasing the angle of attack to the point where the aircraft stalled. The starboard wing dropped and the resulting impact of the wing tip and starboard undercarriage with the ground, caused the pilot to lose directional control, and the aircraft ran off the strip.

The aircraft involved in this accident is but one of a number of light aeroplanes in Australia which, during take-off, can easily become airborne and climb away at speeds well below their normal take-off safety speeds. It is apparent that some pilots are making a normal practice of allowing these aircraft to climb away at such low speeds. By so doing however, they are exposing themselves to the risk of an accident should some unforseen situation develop such as a sudden loss of lift in gusty wind conditions, as in this particular case, or in the event of an engine failure.

The pilots of these aircraft are strongly advised to hold the aircraft on, or close to the ground until the take-off safety speed prescribed in the flight manual is reached, and on no account to attempt climb away at a speed below the take-off safety speed. This technique is the accepted practise in heavy twin and regular public transport operations, and, if adopted by the pilots of the light aircraft, could help avoid further accidents of the type we have just described.

The aircraft upside down in the wheat crop.





TAXI-ING IS SO EASY OR IS IT ?

COMPARED to most other manipulative skills in flying, and the training time and effort that has to be spent to develop these skills to an acceptable standard, the ability to taxi an aeroplane safely on the ground would seem the most simple of manoeuvres — certainly it is the easiest to learn. This is especially so today, with most types of light training aeroplanes equipped with tricycle undercarriages.

Yet, to judge from the numerous reports that the Department has been receiving lately, taxi-ing aeroplanes appears an undertaking literally fraught with pitfalls of one kind or another. Perhaps, it is — or is it just that taxi-ing *seems* so easy that some pilots mentally "switch off" their usual "in command" level of alertness once their aeroplane is (apparently) safely on the ground? It may be significant that most taxi-ing accidents involving collisions with objects on the ground occur *after* landing rather than while preparing to take off.

For the most part, taxi-ing accidents fall into two categories:—

- Minor collisions with objects such as posts, hangar buildings, equipment left on aprons, or other aircraft on the ground.
- Damage caused by ground operations on unsuitable surfaces, usually resulting in one or more of the aircraft's wheels entering a hole or depression, and the propeller striking the ground.

Accidents in the first category are obviously the ones which leave the most room for improvement. Most mishaps of this sort are not really "accidents" at all, in that they *need* not happen. They occur simply because some pilots attach insufficient importance to taxi-ing, are distracted at a critical moment, or are even reckless. Mishaps of this type could no doubt be drastically reduced in number if pilots took more care and always made a conscious resolve to manoeuvre safely on the ground.

Quite a number of accidents in the second category are also avoidable — such as those which result from manoeuvring outside the boundaries of prepared movement areas, but in general aviation operations as a whole, taxi-ing accidents of this type pose a much more complex problem.

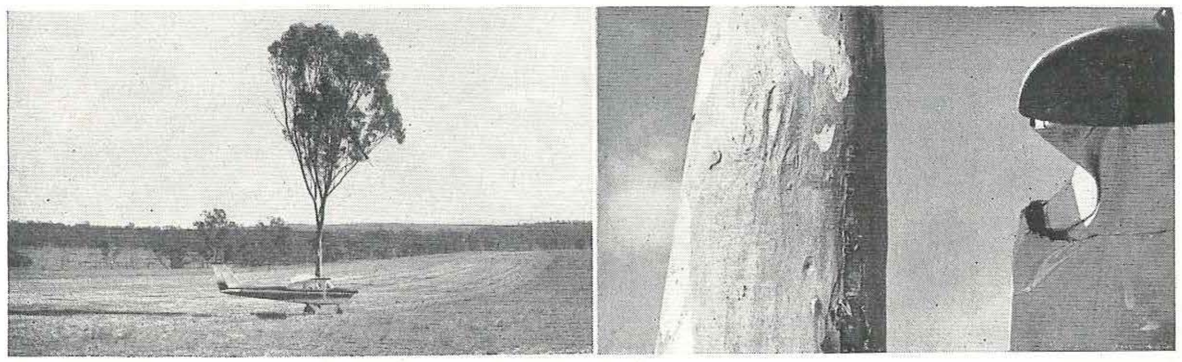
The reasons for this are as various as the types of surfaces from which light aircraft operate. Soft ground, undulations, holes, tree stumps or rocks concealed in long grass — all these can be the cause of damage to an aircraft taxi-ing. Then too, the design of a particular aircraft is another factor. Nose wheel aircraft are more prone to damage on unprepared surfaces than tail wheel types, and even among different types of nose-wheel equipped aeroplanes, design considerations such as propeller clearances, length of wheel-base and undercarriage damping, all have a bearing on an aircraft's propensity to sustain damage. Experience is in fact proving that some types of light nose-wheel aircraft are particularly vulnerable to propeller damage if they happen to encounter a small depression, or a soft patch of ground, while being taxied, or if they are merely taxied other than very slowly and carefully over an uneven or slightly undulating surface. Any of these factors can be sufficient to reduce the already small propeller clearances of these aircraft, to the point where the blades come in contact with the ground.

Accidents in this category occur most frequently in country or "bush" operations from aerodromes classified as Authorised Landing Areas. Many of these aerodromes have been constructed by bulldozing trees and scrub off a suitable area and filling in the holes left in the ground. The holes are completely covered over and the surface levelled by a grader when the strip is completed, but in the case of a hole left by the roots of a large tree, it may take some time, even a matter of years, for the filling to consolidate properly. The danger from these potentially soft patches is usually greatest after rain has fallen and the comparatively hard surface crust of the strip has been softened. In these circumstances, the nosewheel of a light aircraft can easily break through the surface crust and sink into the soft soil underneath, allowing the propeller to strike the ground. (See illustrations.)

Hazards of this sort, are frequently very difficult to detect and, because the soft patches are usually comparatively small in area and isolated, they can defy the most conscientious strip inspections, even including the running of motor vehicles over the strip. The result is that, time and again, soft patches are only detected when an aircraft nose-wheel sinks into one and the damage is already done.

There is obviously no complete answer to this problem and its very nature should stimulate pilots to be more than usually wary when operating nosewheel aircraft on anything but properly prepared aerodrome movements areas. The truth of the matter is of course, that some of the light aircraft types that are in widespread use today, are not really suitable for operations on anything but prepared aerodrome surfaces, and they are, in a sense, out of their element when being employed as bush aeroplanes. This is evidenced by the fact that aircraft specifically intended for bush-type operations are generally fitted with larger section,

The result of inattentive taxi-ing on a bush airstrip.



The result of manoeuvring outside the boundaries of prepared movement areas. Note the damage to the propeller.

lower pressure tyres, and in most cases with "conventional" or tailwheel-type undercarriages which, though requiring greater ground handling skill, are, as already discussed, less vulnerable to damage and provide much more satisfactory propeller clearances. Indeed, it is probably the apparent ease with which modern, nosewheel equipped light aeroplanes can be manoeuvred on the ground that induces pilots to take liberties with them when taxi-ing over rough, uneven or soft surfaces.

With the large number of variables that are involved, there can of course be no hard and fast rules, but a greater sense of caution is plainly one of the first ingredients necessary in any campaign to reduce the type of taxi-ing accidents under discussion. Commonsense precautions such as keeping to obviously-used taxi paths and keeping within defined boundaries of taxiways and the boundary markers of movement areas are measures which all pilots can discipline themselves to adopt. When operations on rough surfaces *are* unavoidable, techniques such as taxi-ing with extreme care with the control column firmly held back and the judicious use of throttle and brakes, which virtually lifts all the weight off the nose wheel, can reduce the risk of the aircraft nosing down into a hole or soft patch, and at the same time achieve an increased propeller clearance. Similarly, when taking off from a rough or doubtful surface, the intelligent use of elevator can reduce to a minimum, the risk of damage to the nose wheel and its attachments.

Winter rains turned this small area of an outback strip into a bog, though it was not apparent on the surface. Before the aircraft landed, the strip had been inspected and passed as serviceable.

After making a normal landing on an apparently serviceable outback aerodrome, the nose-wheel of this light twin broke through the surface crust and sank 11 inches into the mud beneath. The resulting drag collapsed the nose-wheel strut. Heavy rain had fallen during the three weeks preceding the accident.

The weight of evidence available to the Department from its accident files shows conclusively that the safe ground operation of nosewheel equipped light aircraft on any but prepared aerodrome surfaces cannot be taken for granted, but is rather a task requiring the highest level of vigilance. Certainly the consequences of a taxi-ing accident are not likely to be as dire as those that result from one to an aircraft in flight. Indeed, the damage resulting from a taxi-ing accident may not even look much in many cases! Yet they can still be very costly and time consuming. For example, the cost of repairing even a slightly bent propeller and a damaged nose strut can be $180, quite apart from any associated expenses such as transport and travelling time to and from the accident site. If the propeller has been more seriously damaged and requires replacement, as can occur as the result of striking even soft ground heavily, the cost may well exceed $350. And when the impact is sufficient to affect the nose strut attachment brackets and distort the firewall, however slightly, the repair costs can amount to $1,000 or more!

Another factor not always appreciated, is that damage sustained in a taxi-ing accident can have serious effects on the structural integrity of an aircraft, even though it may not appear to be damaged much and still looks airworthy. As a result, an aircraft that has been involved in a taxi-ing accident can be dangerous to fly, as well as expensive to repair.

Taxi-ing accidents can, in fact, produce troubles seemingly out of all proportion to the occurrence itself. Why take the risk when it can be avoided?

FROM THE INCIDENT FILES

Compass Reading Affected

While carrying a spraying machine fitted with a two-stroke motor in the cabin of a Cessna 172, a pilot making a 35 mile cross-country flight from Top Springs to Camfield in the Northern Territory, found he was seven miles off course after flying the first 20 miles. Suspecting the accuracy of the compass, the pilot advised Darwin accordingly and continued the flight to his destination by following the well defined road which links the two homesteads.

After landing at Top Springs, the pilot unloaded the machine which had been stowed behind the pilot's seat and found that the compass indication immediately moved ten degrees. Further checks by the pilot established beyond doubt that the presence of the spraying machine in the cabin had been affecting the compass reading. To ensure that the compass was still serviceable however, the pilot left the spraying machine at Top Springs and returned the aircraft to Darwin, navigating via the prominent Victoria River to the coast and then following the coast to Darwin. Here a compass swing confirmed the compass readings were in according with the aircraft's compass deviation card.

In different circumstances, this incident could well have had far more serious consequences and should serve as a warning to pilots of the care that needs to be exercised when they contemplate carrying comparatively large and heavy ferrous metal equipment in their aircraft.

Hazardous Obstruction To Controls

While carrying out a cockpit check immediately before taking off from his station property, the owner of a Piper Cherokee found that the control wheel became obstructed at about the 11 o'clock position when he attempted to apply port aileron. He taxied the aircraft back to its hangar and removed the inspection cover beneath the port wing. Examining the aileron control linkage while the port aileron was moved carefully, the pilot discovered an engineer's file, complete with handle, jammed between the port aileron bell crank and the wing rib. The pilot checked to ensure that no damage had been caused to the wing or aileron structure, then replaced the inspection cover.

After the incident was reported, efforts were made to determine how and when the file could have been left in the wing. Examination of the log books showed that the aircraft had last undergone an inspection for the renewal of its Certificate of Airworthiness, two years before. Subsequent to this, it had undergone a 100 hourly inspection one year previously, and shortly afterwards the starboard fuel tank had been repaired by a maintenance organisation. Apart from these log book entries, there was no record of any other work having been performed on the aircraft during the two years preceding the incident. The file found in the wing was of German make but was of a type readily available throughout Australia.

The incident serves to illustrate two vital air safety lessons. The first is of course the importance that engineers and their assistants should attach to properly cleaning up, and accounting for all their tools and equipment, when completing work on an aircraft. The second and equally vital lesson of the incident, is the importance of properly checking the flying controls to the full range of their travel before each and every flight. Clearly, the file had been in the wing of the aircraft for a considerable period without causing any difficulty, and it was not detected until this particular cockpit check. The pilot had made a brief flight shortly before the obstruction was discovered, and if he had not bothered to carry out a further cockpit check for this next flight, the obstruction may not have been noticed until the aircraft was airborne. Had this occurred the stage could well have been set for a serious or even fatal accident.

The Case of the Missing First Officer

An airline DC-3 was carrying out night flying training with a captain and two first-officers on board.

After the aircraft had completed a number of successful circuits and landings, the rear cabin door warning light illuminated during a take-off. The captain closed the throttles and abandoned the take-off, then instructed the supernumerary first-officer to check and secure the rear door. Shortly after the supernumerary first-officer had left the cockpit to examine the door, the tower called the aircraft and requested it to back-track to the runway threshold.

When he had taxied back to the end of the runway, the captain saw that the door warning light was still illuminated. As the first-officer had not returned to the cockpit, the captain set the parking brakes and, leaving the other first-officer in the right hand seat to monitor the cockpit, went back into the cabin to see what had happened. The captain found the rear door unlocked and no sign of the third member of the crew. The captain checked the whole aircraft including the rear locker, but the first-officer had vanished.

The captain returned to the cockpit, advised the tower of the situation and the aircraft was requested to taxi clear of the runway to make way for an incoming aircraft. At this, the captain expressed concern that the missing first-officer could have fallen from the aircraft while it was taxi-ing, and could be lying injured on the runway. The tower therefore requested the fire crew to carry out an inspection of the strip while the incoming aircraft was held. In the meantime, the captain taxied the aircraft back along the taxiway. As he was doing so, the captain sighted a person in the glare of the landing lights walking back towards the aircraft. It proved to be the missing first-officer. The aircraft advised the tower to this effect, and the fire crew were recalled.

The first-officer was uninjured and explained he had jumped from the aircraft while it was stationary to check the rear locker door, but the aircraft had taxied away from him while he was still on the runway. Realising the problems his disappearance would cause, he left the runway and proceeded to walk along the taxiway in the direction of the aircraft.

The moral of this story is obvious. All the trouble it caused, including delaying an incoming overseas flight, as well as the anxiety that was felt for the first-officer's safety, would have been avoided if the first-officer had bothered to tell the captain he was getting out to check the rear locker door.

SEAT JAMS CONTROL COLUMN

Cruising at 2,500 feet, the course of a solo cross-country flight in Queensland, the pilot of a Cessna 172 reached down to pick up his computer which he had laid out on the right hand front seat together with his maps and flight plan. The computer was not there and the pilot assumed that it had fallen under the seat. In the process of searching for the computer, he moved the vacant seat forward on its rails and in order to look behind it, pushed the back of the seat forward. Immediately, the aircraft nosed over into a relatively steep dive, which the pilot found he was unable to correct because he could not pull the control column back. Looking quickly for the cause of the obstruction, the pilot saw that the upper edge of the seat squab had pushed the right hand column forward and was jammed under the control wheel, preventing any backward movement. Before the pilot could disengage the control column from the seat back, he found it necessary to first move the column even further forward, to free the seat squab so that he could regain full control.

The pilot later had the seat installation checked, but found that it was correctly installed and that the stops on the seat rails were in position. He also examined other Cessna 172 aircraft and found that some models had lower seat backs which when pushed forward could not interfere with the controls. In reporting the incident, the pilot said he believed there could be other types of aircraft in which the same type of incident could occur and he felt pilots should be forewarned of the possibility.

Check your Ignition Switch!

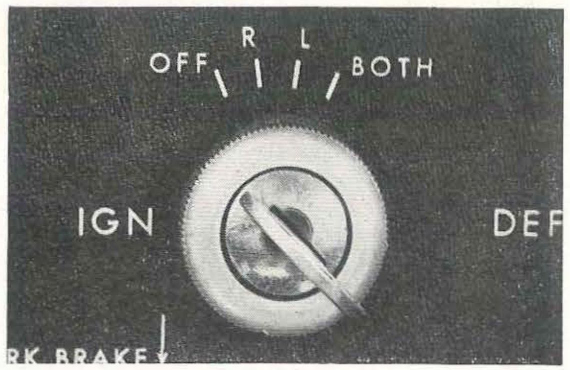
Approaching Geraldton, W.A., after a flight from Jandakot, the pilot of a Cessna 175 called the Flight Service Office and advised that he would be making a straight-in approach as his engine was missing badly. The aerodrome fire service was alerted and stood by while the aircraft made a normal landing.

Examination of the aircraft by a licensed aircraft maintenance engineer revealed that the engine was operating on the left hand magneto only. The situation had arisen because the indexing of the magneto switch positions on the switch placard, was out of alignment with the actual switch detents. When, according to the indexing, the "Both" position was selected, it was found that the switch was actually in the "left" magneto only position.

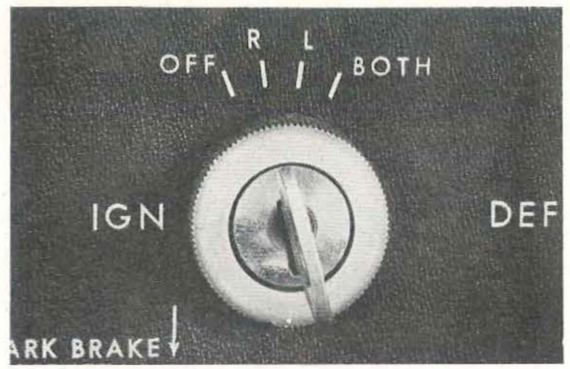
As a result of this incident, surveys were made at Moorabbin and Jandakot airports to determine to what extent other aircraft were affected. Out of some 30 Cessna aircraft inspected, comprising models 150, 175, 180, 182 and 210, at least another eight cases were found in which the magneto switch indexing was incorrectly positioned. In one instance, a Cessna 172's switch was inspected after the engine had been started, just as a student pilot was about to taxi out for a period of flying training. The student had the ignition in the left magneto detent in the belief that it was in the "both" position.

The errors found in the indexing positions fell into two categories. In some early model Cessnas, the body of the switch itself had rotated a few degrees in its mounting on the instrument panel, causing misalignment with the switch position markings on the panel itself. In more recent aircraft, the switch is keyed into the panel to prevent this rotational movement, but in some models the markings on the panel are inadequately spaced. In these cases, movement of the ignition key throughout its range, produces a much greater degree of rotation than is provided for by the index markings. This type of error is illustrated in the accompanying photographs.

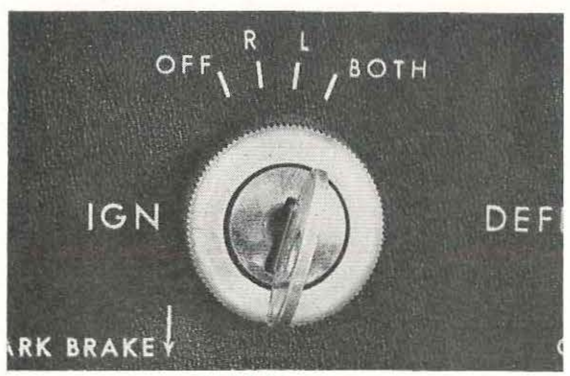
The consequences of these errors are likely to be felt most by aero clubs and flying schools, where a large percentage of the flying is being performed either by comparatively inexperienced pilots who tend to fly very much "by the book," or by other pilots who do not fly any one aircraft sufficiently to become familiar with its idiosyncrasies. In circumstances of this sort, it is almost certain that faulty switch indexing will sometimes result in engine operation on one magneto only. This could well be the explanation for some of the cylinder and piston troubles that occur from time to time, as well as for the occasional reports that are received of dead cuts on one magneto during magneto checks.



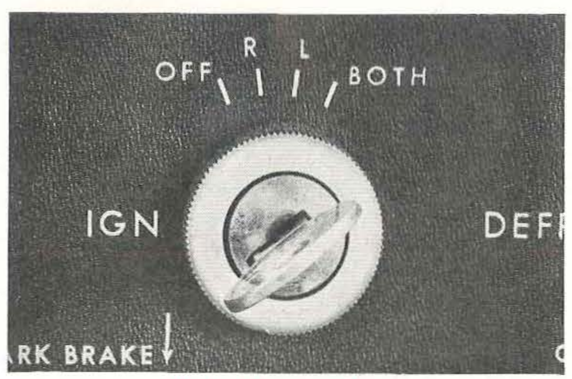
"Off" Position.



"Right" Magneto.



"Left" Magneto.



"Both" Magnetos Position.

A Message for C.F.Is. and Student Pilots

In our Editorial in the December, 1965 issue of the Aviation Safety Digest, the Department explained in some detail, a new distribution policy by which the Digest was to be made available to student pilots through their aero club or flying school.

Since that time, many new Student Pilot Licences have been issued and it is obvious that many of the newer students have neither seen the original Editorial, nor had the distribution arrangements which it explained, brought to their attention by the flying school or aero club to which they belong. This fact is evidenced by the increasing volume of letters the Editor is receiving from student pilots, asking to be placed on the Digest distribution list.

This is a situation which should not occur, and which can be avoided in future if flying schools and aero clubs will ensure that their students understand the Department's distribution policy, and provide some means of allocating a copy of each issue of the Digest to those students who are entitled to it. Obviously, merely dumping a pile of Digests on the briefing room counter, with a "Please Take One" notice, does not achieve the intended result!

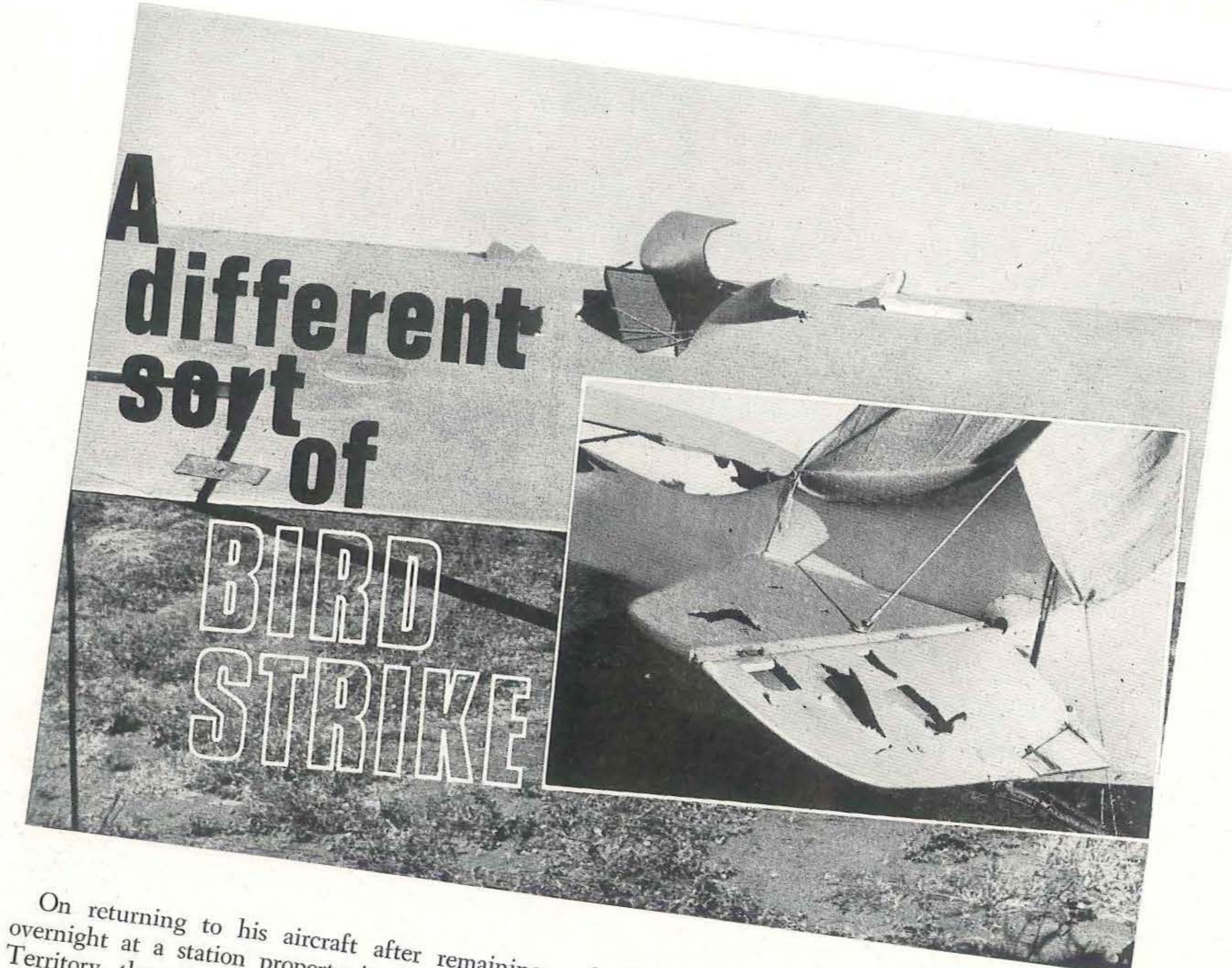
For the benefit of students who have not seen the original Editorial, the most relevant paragraph reads:—

> *". . . . . the Department has now decided to make a selective distribution to student pilots, who have reached solo stage, who have logged not less than 15 hours flying and who are receiving regular flying instruction."*

Students who are eligible to receive the Digest, but who have difficulty in obtaining a copy each time it is issued, should take up the matter with their Chief Flying Instructor, rather than write directly to the Department. If any flying school or club is receiving insufficient copies of the Digest to accommodate all their eligible students, the Department is quite prepared to consider any reasonable request for an increase in the number forwarded, but any such request should be made officially by the flying school or club and not by individual students.

The Department, in the interests of air safety, goes to very considerable expense to produce and distribute the Digest to those who are likely to benefit from it most. Student pilots, who have not yet had the opportunity to build up a background of operational experience of their own, are clearly in the forefront of this category — that is why the Department introduced a system for making the Digest available to students. It is surely not asking too much of flying training organisations to see that the copies of the Aviation Safety Digest they receive, are used, as the Department intended, to the best possible advantage in inculcating a greater consciousness of Air Safety amongst those who are learning to fly.

A different sort of BIRD STRIKE



On returning to his aircraft after remaining overnight at a station property in the Northern Territory, the pilot of an Auster Autocar found that the fabric on the upper surface of the wings had been badly damaged and torn. Some pieces of the torn fabric were lying on the ground nearby. The station's airstrip is situated close to the Stuart Highway and as the aircraft was plainly visible from the road, the pilot's first thought was that vandals had caused the damage so he returned to the station to obtain the services of some native trackers.

A careful search around the aircraft by the trackers however, discovered no human tracks but rather the marks of many birds. Further examination of the aircraft then showed that the red flag attached to the pitot cover had been chewed away and that there was a considerable amount of bird droppings on the tailplane where the fabric had been slightly damaged. The native trackers suggested that the damage had most likely been caused by galahs or crows. To try and prevent further damage, the pilot covered the entire wing area with hessian and moved the aircraft to what he considered to be a more suitable position. Here he tied it down, pending repairs to the upper surface of the wing.

When the pilot returned to the aircraft a week later to carry out the repairs to the wing, he discovered that considerably more damage had been sustained by the tailplane. In addition, the hessian covering on the wings had been lifted and further damage had been done to the wings.

The aircraft had been resprayed all over in aluminium dope shortly before the incident and the registration lettering had been repainted in red. In view of this and the damage to the red pitot cover, the pilot said he thought it likely that the red colouring had attracted the birds. A number of crows remained in constant attendance around the aircraft while the repairs were being carried out, and displayed a marked interest in pieces of the fabric.

THE STAGE IS SET . . . .

- **Inattention to airspeed and attitude**
- **Excessively steep turn**
- **Insufficient height for recovery from a stall**

This sort of performance may seem innocent enough. But so often the final act becomes a tragedy!